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ANATOMY

OF THE

DENTAL SYSTEM,

HUMAN AND COMPARATIVE.

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INTRODUCTION.

The recent progress of comparative anatomy has rendered it very difficult to give, what has not yet been satisfactorily done, an exact definition of the teeth. To say with Beclard, that they are little bones, implanted in the alveoli of each jaw, would be to confine ourselves within too narrow limits; this definition not embracing the teeth of some animals; as, for instance, the palatine and pharyngeal teeth of fishes. On the other hand, to adopt the definition of more modern zoologists, and call the teeth opposing bodies, placed at, or near, the entrance of the alimentary canal, for the purpose of seizing and grinding the food, would be to fall into an opposite difficulty, and to confound with the teeth, parts which have, perhaps, little analogy to them; the greater part of the masticatory organs of the invertebrated animals.

Obliged, however, to characterise my subject, at the outset, I, at once adopt the definition of Cuvier, and call the teeth: "mechanical instruments, harder than the bones, placed in vertebrated animals, at the entrance of the alimentary canal, and destined to seize and separate the nutritive substances, or to serve as means of attack and defence."

Circumscribed, even in this manner, the natural history of the teeth is still a subject of considerable extent, and embraces, in man, and in the series of animals, a great number of facts, which, notwithstanding the differences they appear to present, at first sight, are reconciled to each other by remarkable analo-

gies. We are enabled to study them in two manners, essentially distinct; either to take up the human anatomy as a starting point, examine, first, the dental system of man, and then comparing with it that of the inferior animals; or to take up the general consideration of the subject, and, then examine, particularly, the dental organs of each class.

The first of these methods which I shall adopt, is, doubtless, more extended, more attractive, and more philosophical than the other, I shall not forget, however, that the human organization is of primary importance, and that all facts in comparative anatomy should be made to assist in its elucidation. In treating my subject, I shall proceed in the following manner: First, I shall give a sketch of the history of the anatomy of the human dental system; I will examine, cursorily, the dental system in general; then describe, with the greatest care, the teeth of the human species, and conclude by showing the modifications presented by these organs in the whole series of inferior animals.

ANATOMY OF THE DENTAL SYSTEM.

PART I.

HISTORICAL SKETCH OF THE ANATOMY OF THE TEETH.

There are few subjects connected with the science of medicine, to which so much attention has been given, as the one we propose to take up; what has already been written and published, with regard to it, could scarcely be contained in two hundred volumes. But are we to conclude, on this account, that all useful information with regard to it has been given, and that the matter has been exhausted? Certainly not. Much yet remains to be said upon this interesting subject, and there is more than one doubt to clear up, more than one difficulty to solve. Will it be objected to this undertaking, that our libraries are, already, overcharged with an immense quantity of superfluous works? What signifies the number? What does it matter, if each dentist, past and present, has believed it his duty to write a volume, and to publish his lucubrations to the profession? What does it signify, if each of them, in one of those accessions of self-satisfaction, so common amongst authors, may have had the presumption to believe that he had, finally, discovered the last secret of the dental organization? It has always been the case that this boasted wealth of discovery is nothing but pretension. To obtain any adequate idea of the slow progress of discoveries in the natural history and anatomy of the teeth, it would be necessary, as I have been compelled to do, to traverse the eternal succession of treatises, essays, and rebutting compilations, which have succeeded each other with a desperate constancy, from the infancy of the science down to the present time, and with the microscope of history in hand,

to search out the smallest truths, amidst an endless and confused mass of absurdities. But what has struck me most forcibly in these historical researches, is the constancy with which real discoveries, have been, successively, combatted and repulsed by errors which have taken their places. Thus, for instance, Fallopius and Eustachius, those skilful correctors of the illusions of Vesalius,—indicated the true characteristics of the structure and developement of the teeth, yet their fine researches were scarcely noticed in their day; and we are now compelled, after nearly three centuries of useless controversy, to return almost to the point whence they started.

We shall find, in the course of this historical exposition, many, as they are now regarded, novelties, the origin of which is of very ancient date,—discoveries with a very numerous paternity,—children born before their pretended fathers.

That this historical sketch may have some degree of order, I will divide it into several periods, which will give the mind of the reader time to repose, and will enable me to support, with more ease, the ennui consequent upon researches which are not without labor and difficulty.

PERIOD I.

FROM AN INDEFINITE TIME IN THE DISCOVERIES OF EGYPT, CHINA AND GREECE, TO ARISTOTLE.

According to Herodotus the dental art amongst the Egyptians, from the most ancient period, was reserved to a particular caste, which gave to it exclusive attention.

In a report of the examination of a mummy, communicated by M. Villeteau to M. Sylvestre de Sacy, it is stated that the teeth, although they appeared to have been worn by mastication, and had lost their cutting edges, seemed to have escaped disease, and were, otherwise, in a good state of preservation. He mentioned also, as a remarkable fact, that the Egyptians of the present day have very fine teeth, and preserve them, in good condition, to the most advanced periods of life.

To this meagre result is reduced all my researches in the pretended anatomical knowledge of the learned sages of Egypt, this old cradle of the sciences; and even for these facts it has been necessary to make a demand upon the silent tomb.

The records of this period of China, throws but little light upon our subject. It is not surprising, indeed, that a people, who regarded the dissection of a dead body as an unheard of cruelty, and for whom the human bones were a frightful spectacle, should have made few advances in anatomy. They have, however, classed animals, after their external characteristics, and the teeth have furnished useful data in this first attempt at a zoological division.

Nothing of consequence is to be found in the first annals of Greece, with regard to the subject in question; nearly every thing has been destroyed by time. And all that I find remarkable, in this long series of ages, is, the philosophical definition which Homer has given of the teeth, which he calls "*little barriers, so placed by nature, as to prevent the rambling of the tongue, and the abuse of speech.*" It must also be stated, that Eristratus mentions an extracting instrument, of lead, which was suspended in the temple of Apollo, to indicate that skill, rather than force, was necessary for the extraction of the teeth, as, when proper means were used they were unable to resist even so fragile an instrument.

We must come down to the times of the Greek philosophers to find any real indications of a knowledge of the teeth; and we have gathered in the works of Hippocrates all the ideas which were then held. It is very extraordinary, however, that Alcmeon of Crotona, who had a knowledge of the existence of the tympanum of the ear; Democritus, who dissected the brain for the purpose of finding the seat of madness; and Empedocles, who, according to Plutarch, had found in the temporal bone, a body in form like a snail, should have had no more exact knowledge of the teeth, than what has been transmitted to us by the physician of Cos.

Hippocrates said:—*Frigidum inimicum ossibus, dentibus, nervis, cerebro, dorsali medulæ; calidum verò amicum.* Some authors contend that Hippocrates, in this aphorism, has made

a distinction between the teeth and the bones; but it appears to me to be a strained inference. It is more probable, that he wished to indicate that the teeth, amongst the bones, were more particularly affected by the action of cold; indeed, he removes all doubt with regard to this point, himself, for, in other aphorisms, he distinctly calls the teeth, bones.

He has dwelt, particularly, upon the phenomena of dentition; and upon the disorders of which they are the causes. He has also spoken of the symptoms furnished by the teeth in some maladies; and what is more remarkable, in an anatomical point of view, has stated, that the germs of these organs are developed in the fœtus. He called the wisdom-teeth σωφρονισηρες and was of the opinion, in which he has been sustained by many authors, since his time, that a great number of teeth is a sign of longevity. He believed, also, that the setting on edge of the teeth, of a pregnant female, was a symptom of superfœtation.

PERIOD II.

FROM ARISTOTLE TO GALEN.

ARISTOTLE, that superior genius, whose anatomical knowledge was so extraordinary for the age in which he lived, is the first who has devoted a chapter, of any length, to the consideration of the teeth. He is the first writer that treats of them in an extended and philosophical manner, and examines them in relation to their comparative anatomy.

This chapter, it is true, contains many gross errors, but it will be found not the less worthy of attention, when it is remembered that Aristotle wrote three hundred and fifty years before the christian era. The progress of this branch of anatomy will be better appreciated by giving, at this place, a general view of the opinions advanced by him.

Aristotle noticed that there were marked differences between the human teeth and those of the inferior animals, and between

the different species of the latter. All the viviparous animals, according to him, have teeth, but not always an equal number in each jaw. In horned animals, the anterior upper teeth are wanting, which arrangement is also to be found in some animals without horns, as the camel. Some animals are furnished with tusks, (*des dents saillantes*) *en dehors* as the boar; in some, as the lion, panther, dog, &c., they resemble the teeth of a saw, in others, the surfaces are flat, as in the horse, ox, &c. No animals have at the same time tusks and horns, and those which have their teeth arranged like the teeth of a saw, have neither tusks nor horns. The front teeth are generally more pointed than those in the posterior part of the jaw; the teeth of the seal, however, are all pointed as if to indicate that this animal formed the connecting link between quadrupeds and fishes. No animals, he says, have a double range of teeth in the same jaw, although Ctesias would have us believe that there exists in India an animal called Martichore, which has a triple range.

Aristotle considered the tusks of the elephant positively as teeth. He said, also, that the anterior teeth, only in man, were shed; that the molares were never changed in any known animal; that none of the teeth of the hog were shed; that the age of many animals is indicated by their teeth, which assume a blackish color as the animal grows old; he mentions the teeth of the horse, however, as an exception to this general rule, as they become, on the contrary, white with age. That animals with pointed teeth, have, generally, a very large mouth.

Aristotle believes, with Hippocrates, that those animals which have a great number of teeth, live longer than those which have them in small numbers, and separated. He remarked, also, that men have more teeth than women; which arrangement, he said, is found to exist in the females of some animals, as the sheep, the she-goat, and the sow. It is difficult to conceive how an error like this could have been advanced by such an anatomist as Aristotle, and we are forced to conclude, either that his text, has been altered, or that he was, as some authors have thought, merely the historian of the anatomical discoveries of his time, and had never himself, made dissections.

He considered the beaks of birds as representatives of their

teeth, and as analogous to the horns and nails of animals; a strange contradiction, however, he says, that the teeth are of the same nature as the bones, (οι δε οδουτες κατα την των οσθων εισι φυσιν:) with this exception, that the former possessed the power of reproducing themselves.

From Aristotle to Galen, this branch of anatomy made very little progress; it is probable, however, that Herophilus and Erasistratus, those bright ornaments of the Alexandrian school, did not allow this subject to pass without throwing some light upon it; but, if they have given it any attention, the result of their labors have not reached us. From what has been said by Celsus, of the diseases of these organs, and the operations practised upon them; and from the advice given by Archigeneus, to perforate the tooth with a little trepan, when painfully affected, it is evident that they had made some advances in the anatomy of the teeth, and understood something of their structure.

We perceive, at once, the depth of the knowledge of Areteus with regard to the structure of the teeth, when we find him saying, that God only knows the cause of tooth-ache.

Pliny, the universal compiler and narrator of fables, as he has been called, was more of a historian than anatomist, and has not progressed farther than Aristotle; he has only added some more errors and many anecdotes, more or less absurd, in relation to this subject. He says, for instance, that the human teeth contain a mischievous poison, and that their bite is capable of producing the death of weak animals. The presence of two canine teeth on the right side, was considered by him, the presage of success in life. He relates, that the soldiers of the army of Germanicus Cæsar, whilst they were encamped in Germany, lost all their teeth by drinking, for two years, of the sweet waters of a fountain to which they had access. He cites a great number of instances of varieties of forms, observed in the human teeth. Hercules, he says, had a triple range of teeth; the sons of Prusias, Curius, and Papyrius, whose history is so familiar, are also mentioned;—they were born with teeth, on which account, they were called the *Dentati*. He mentioned instances of the developement of palatine teeth and other anomalies.

Aristotle said, that those animals which were not furnished

with front teeth, to serve as defensive weapons, had horns, as a sort of compensation; but Pliny, with reason, denies the truth of this statement and instances the kind which has neither.

PERIOD III.

FROM GALEN TO VESALIUS.

Galen, rich in the labors of his predecessors, particularly the Alexandrians, gives a better description of the teeth than any one who wrote before his time. He states that they are formed during gestation, but remain shut up in the alveoli until the period of birth; that the superior molar teeth have three roots, whilst those of the inferior jaw have but two; and says, that the canine were designated eye-teeth, (ὀφθαλμιχοι,) because they received branches of a nerve which goes, also, to the eye.

He has written a long chapter upon the forms, the functions, and the evolution of the teeth, which he believed to be true bones: *in ossium numero dentes habendi sunt, etsi secus nonnuli sophistæ arbitrentur.* As he confined his dissections to the inferior animals, he gives to the human system parts which do not belong to it, for instance, the inter-maxillary bones. He believed that the teeth are not endowed with sensibility, and gives for proof: *Quære utriusque doloris sensum expertus, alium quidem gengivis, alium ipsius dentis substantiâ esse non dubito.* He relates the circumstance of a number of slaves, who, after having had their teeth extracted, with violence, died of convulsions.

The teeth, says Actius, are perforated at the extremities of their roots, and these openings give passage to filaments coming from the fifth pair of nerves, or trigemini; in consequence of which, they have a higher degree of sensibility than the other bones. These remarks already approach nearer the truth than any others with which we have met, and certainly do honor to their author, when the remote period at which he wrote is

taken into consideration. This author believed, also, that the teeth continued to grow till old age, by the deposition of a nervous fluid which is secreted in the interior; but at that period of life this process of nutrition ceased, the teeth become loose and fall out.

Rhazes described the phenomena of dentition, but in a very imperfect manner. What is most remarkable, with regard to him, is, that he opposed, according to Sprengel, the use of hard bodies, sometimes placed in the hands of infants, to assist first dentition, and proposed the substitution of frictions upon the gums.

Avicenne made no more additions than the preceding author, to the store of knowledge already accumulated with regard to this subject; he was a servile follower of Galen, was able to see nothing but what had been discovered by that anatomist; as he was easily satisfied, therefore, he did not make great advances.

Abulcasis was the first who attempted to supply the loss of the teeth, by the insertion of others, either human or artificial, and he states that it requires a great deal of skill to succeed. I have cited this fact on account of its relation to dental physiology, and, as I do not wish to return to the subject, I will break in upon the chronological order, I had determined to observe, and state here, that Ambrose Paré has related the first instance, at all authentic, of the successful transplantation of the teeth: "A man worthy of credit," he says, "affirmed to me, that a princess having had a tooth extracted, had another taken from the mouth of one of her maids, and placed in the cavity from which her tooth had been taken; after the lapse of some time she was able to use it with as much ease, and it was as useful to her as the one she had lost. This, however, did not come under my own observation."

Benedictus mentions cases of teeth developed in the palate, but has left nothing worthy to be cited.

Paracelsus considered the premature developement of the teeth as anomalous, and called those children, which were born with teeth, monsters.

Fracassator is among the first writers who have indicated the sympathetic connection between the ear and the teeth. *Si-*

militer esti cutus valdẽ sit sonus et stridulus, applicationis vim patitur membrana auditûs ; et quasi ista offenditur, undẽ contrahitur repentẽ ac cum ea simul et nervuli quidam usque ad radicem dentium, in quem locum incidens subitõ novus ae horrorem quemdam circà dentes facit.

PERIOD IV.

FROM VESALIUS TO HARVEY.

Vesalius did not study the teeth with the same care which he gave to the other parts of the body, and he has, consequently, left nothing which we can usefully transcribe here ; he gave a description of the teeth, but it was very short, and without importance. He believed them to be analogous to the bones, from which they differed, in being uncovered, and each possessing a particular sensibility derived from a nervous filament received by the root; he thought, also, that the milk-teeth served as germs to the permanent. This exposition, it will be perceived, leaves much to be desired, and is unworthy of an anatomist as distinguished as Vesalius.

Eustachius devoted more attention to the consideration of the teeth than any one who preceded him, and he has added much to the store of their anatomy. He gives a full description of their different forms, their number, and varieties ; he indicates their manner of articulation, and the nature of their attachment to the sockets, which, however, he does not very clearly explain ; (*adsunt præterea vincula fortissima radicibus præcipuẽ adherentia:*) he afterwards speaks of the adhesion of the teeth to the gums as analogous to the attachment of the nails to the skin ; (*sicut cutis extremæ unguium parti adhærescit, ità gingivæ dentibus adjunctæ sunt.*) He thought, with the ancients, that the hardness of the teeth of animals was in proportion to their ferocity.

He examined the structure of the teeth with much care, and was acquainted with the two substances which enter into their

composition; he compared the enamel to the bark of the tree, (*duplici substantiâ veluti arbores tegunter sic, &c.*) In an article upon the developement of the teeth, he describes the dental follicles, their blood vessels and nerves, and refutes the doctrine advanced by those who believed that the roots of the temporary teeth served to form the permanent, and that, although, the germs of the permanent teeth are too small to be distinctly seen in the fœtus, they really exist. He maintains, also, that the teeth are nourished differently from the other bones, and instances, to sustain his position, their inability to repair a fracture of their substance.

Eustachius supposed that the sensibility of the teeth has its origin from the nerves of the follicle, or investing membrane, which he believed, penetrates their substance, and that odontalgia is always more violent when these nerves are strongly compressed; as will be seen from his text; however, he did not affirm this positively, but only hazarded it as a conjecture. *Ego quamquam certam demonstrationem non habeo, conjecturâ nihilominus adducor, ut suspicer nervum, qui in concavitate dentium penetrat, in minutissimos surculos diffusum cum intimâ ipsorum substantiâ, quæ mucosa est initio generationis commisceri.*

He describes, at length, the eruption of the teeth, contends that no analogy exists between the temporary and permanent set, and concludes by a well written chapter upon their functions and utility; he remarks, here, that the most ferocious dogs become timid and cowardly when they lose their teeth. He left, also, some details upon their comparative anatomy, and described, particularly, the teeth of the ape; finally, to leave no part of his subject untouched, he makes mention of a number of curious anomalies, and speaks of four successive dentitions.

Sylvius devotes a chapter to the description of the teeth, but there is nothing new to be found in it; he not only made no further advances than Galen, but copied all his errors. He answered those who brought forward the discoveries of Vesalius to expose the errors of this anatomist, that the physician of Pergamus was not deceived, but that, since his time, the human organization, itself, had undergone a change.

Columbus advises great caution in the extraction of the temporary teeth; as their roots, he says, are necessary to the developement of the permanent set. He makes no mention of the dental follicles, and says, that he is unable to understand why the teeth do not make their appearance until sometime after birth. He thought that, although, they had an unlimited growth, possessed a particular sensibility, and were uncovered by the soft tissues, they should not be classed separately from the bone. (*Quamvis, à reliquis ossibus dentes distinguantur, tùm sensu et quia denudati sunt, quod cæterorum nullis contingit, tùm et quod toto vitæ tempore incrementum suscipiant, &c.*) He spoke, also, of the adhesion of the teeth to the alveoli, &c.

Fallopius (*Opera omnia*, Frankfort edition) says: "*Dentes hi, dùm nascitur puer, diversâ ex materiâ constant, alterâ osseâ et durâ, alterâ molli. Prior pars quâ erupturi sunt ossea et cava, posterior verò mollis admodum et humida est, atque pelliculâ quâdam tenui vestita videtur; quod etiam in origine pennarum dùm adhuc teneræ sunt, apparet. Quoniam pars illa quæ extrà cutem proeminet cornea et dura est, illa quæ in aliis latitatmollis, humidave, vel pituita concreta apparet.*" It is worthy of remark, that he calls the dental substance *cornea*. He notices the disappearance of the alveoli after the loss of the teeth.

He has described the *iter dentis*, not as a passage which the tooth traverses, but as a prolongation of the follicle to the gum: he notices, also, a bony foramen through which it escapes outwardly. It is, undoubtedly, the *iter dentis* which he describes after his manner, and we shall find that the difference is not very great. "*Geminum, apicem possidet folliculus alterum, posteriorem, cui nervulus et arteriola et venula applicantur, alternum vero priorem à quo veluti cauda quædam, pendet nervea, quæ foramen ossis angustissimum ad latus illius dentis, cui novus successurus est, usquè ad gingivas egreditur.*" (It is evident that it is in the teeth of the second dentition that Fallopius notices this particularity.) He then adds, "*Erumpit tandem unusquique dens per id foramen dilatatum per quod anteà angustissimum existens, transmittebatur folliculi cauda à medicta, atque folliculus disrumpitur et dens nul dus, durusque extat, temporisque successu in partibus posterioribus perficitur.*" The au-

thor observes, that it is only by a good deal of patience, labor, and minute research, that he has been able to discover these parts, the existence of which he states to be certain.

Ingrassias had, also, a correct knowledge of the formation of the teeth; he admits four dentitions, one of which occurs *in utero*, the other three after birth. He has added nothing, however, to the previous stock of knowledge upon the subject.

Ambrose Paré, in the sixth book of his anatomy, which, as we are aware, preceded his surgical works, has also described the teeth. He gives as a reason why the teeth of the superior jaw are larger, and have more roots than those of the inferior jaw, "that the latter is more solid than the superior jaw, and the teeth resting upon it, and not being suspended like those above, require less support."

Coïter, who has treated the subject of osteology with so much ability, asserts, positively, that the teeth are not analogous to the bones, that they are formed from a peculiar mucus, and do not pass through the cartilagenous state in their formation; *quum ossa fiunt per intercessionem cartilaginum, dentes vero ex conversione mucoris in dentium substantiam, nullo interveniente medio, opinor dentem non esse, sed proprium aliquod corpus durius, candididius et solidius.* He has described the fangs, and receptacle of the venom of the viper.

Rousset (*lib. de homines primordiis*) relates the case of a woman in Flanders, who menstruated by the alveolus of a molar tooth, which she had lost.

Plater thought that the teeth did not possess any inherent sensibility, and that their apparent sensitiveness should be attributed to the gum which surrounds them.

Forestus mentions an Ethiopian slave whom no one would purchase, because his teeth were all of the canine class, which was considered a bad omen.

PERIOD V.

FROM HARVEY TO BICHAT.

We find that, during this long period, the greatest attention was given to the study of the anatomy of the teeth. A great number of treatises were published upon this subject, but science has gained so little, and new ideas are so rare in them, that I shall be forced to pass silently by the greater part. I will make mention of the most important only, and notice those portions of them only, which are most striking.

Spiegel was aware of the fact, that teeth, with curved roots, were more firmly fixed in their sockets than any others. Scaliger called them bones *sui generis ;* he denied that they possessed a particular sensibility, and supposed them, in this relation, to be analogous to the nails. Kerkring found them entirely analogous to the bones: besides this, he has said but few words upon the subject: *de dentibus nihil dicam aliud, quam nihil esse quod hic peculiariter sit commemorandum!* It is really extraordinary that this author, who studied with so much care, and who was the first to publish a generally esteemed treatise upon osteology, should have passed so lightly over a subject of this importance. Becker and Schrœder have said nothing with regard to the teeth, but what is absurd: they assure us, for instance, that those extracted from a dead body will serve as a preservative against poison, *(veneficia.)*

Thomas Bartholin and Genga, make mention of a tooth which occupied the whole of the alveolar arch. The first says, he saw a man who had an iron tooth, and advances some trifling reasons to explain this phenomenon. Since I am upon this subject I will speak, also, of the famous golden tooth which has occupied so much of the attention of more recent authors, and upon which they have exhausted themselves with ridiculous explanations and puerile commentaries. Ungebaur, who so justly sneers at those who credited this absurd story, thought an explanation of the error might be drawn from a fact, which is sometimes observed in ruminating quadrupeds; the teeth of these animals

take the yellow tinge of the juice of the plants upon which they feed. We find in a dissertation by *Fulschius* (*de vaccillat. et palingensiá dentium,*) that Rhumbaumius saw a child who had a so called, golden tooth, which was exhibited to the public, as a rare curiosity. Rhumbaumius employed a goldsmith to test a small piece of the tooth, which he cut away, who declared it to be really gold. The next day, however, Rhumbaumius made a new examination and found that the tooth was as perfect as it had been before the piece, which the goldsmith tested, was taken away; no trace of the violence which had been done was apparent. This aroused his suspicions, and in examining it with more care, he discovered on a level with the gum, a small hole, into which he inserted an instrument and tore away a layer of gold which exposed to view a natural tooth.

Diemerbroeck has spoken of teeth developed in the palate, the point of which wounded the tongue. By an error very extraordinary for the period at which he lived, enriched as was the anatomy of the teeth by the labors of those of whom we have spoken, he has sustained that the teeth are not formed till after birth, and that they are composed of the superfluous material intended for the general ossification; this is an error for which, however, he is but indirectly responsible, as we find it advanced by Hippocrates. Deimerbroeck has mentioned many curious anomalies; he had, himself, a canine tooth extracted at an advanced age, which was replaced by another; and says, he saw, at Utrecht, a woman, fifty-six years of age, who had two new incisors that supplied the place of those which she had lost two years before.

Gagliard believed the enamel was formed in parallel fibres, and was composed of a concretible juice, which acquired a much firmer consistence than the other bones; it became so hard, he said, as to produce sparks when struck against another tooth or a piece of steel.

Fredericus in a dissertation entitled, *De dentium statu naturali et præter naturali,* has shown great erudition, and has presented a very complete history of the dental system. He opens with a long article upon the importance and dignity of the teeth, *(dignitas dentium.)* He says, that in certain parts of the

Indies, the teeth were formerly so highly esteemed, that they were offered by the people in sacrifice to their deities. He said, also, that the ancients, according to some of their historians, observing that the teeth did not decay, after death, like other portions of the human frame, supposed that in them, was contained the germ from which a new body was to be reproduced at the resurrection. He compares the forming tooth to a grain shut up in its husk, and calls the whole of the phenomena of dentition, germination. *Totus dens primùm inclusus est folliculo sue membranâ tenui ac pellucidâ, non secùs ac granum in aristâ.* He says, that the teeth of the Ethiopians and Indians are whiter than those of the people of the north, but that they lose much of their beauty by the use of the betel to which they are addicted. He notices, in these words, the sympathetic connection between the teeth and the ear; *baculum terra infixum si dentibus arripias, faciliùs aliquem è longinquo noctu advenientem percipies.*

Higmore first related an instance of the penetration of the root of a canine tooth into the maxillary sinus; it occurred in the mouth of a female, who was very much frightened to find an instrument thrust so deeply into her head.

We are indebted to Duverney for a good treatise upon the teeth. He compares the membrane which surrounds the forming tooth, to that which envelopes the fœtus, and calls it the *choroïd*, *tunic*. He says, that the follicle has the form of the tooth it is destined to produce, which he supposes to be formed by super-imposed layers, the external being hardest. The teeth make their appearance successively, according to him, only to save the infant the great amount of violent pain, to which it would be subjected, if they were all to cut the gum at one time. When the tooth passes through the gum, he says it is abandoned by the choroid membrane, which remains in the alveolus to form its periosteum. He believed that a close analogy exists with regard to their development and nourishment, between the tusks of the elephant, the feathers of birds, the hair and the teeth; and gave a good description of the dental vessels and nerves.

"At a certain age," says Duverney, "the cavity in the root is so much diminished in size, that the vessels are much compressed, and disappear almost altogether. At this period, having

lost the power of renewing themselves, they are rapidly worn away by the friction of mastication, and this may be termed the age of the decadence of the teeth." He notices, also, the complete seclusion of the alveoli in old persons, which he attributes to a particular process of absorption, caused by the mechanical action of the gum, and the pressure exercised during mastication. He says, that if the inferior, in old persons, passes in front of the superior jaw, it is in consequence of the disappearance of the alveoli, which, in younger persons, present a greater projection in the latter than in the former.

Duverney mentions the fact, that if a tooth is lost either in the upper or lower jaw, the one which is opposite will become elongated a little, as if, he says, it were making an effort to fill up the vacant place. He admits, that the gums have a vascular connection with the teeth, because it is rarely that the latter remain unaffected, when the former are diseased. He concludes by a special chapter upon the horns of animals, the development of which, he considers in very nearly the same manner as Malpighi.

Bidloo thought, but without offering any proof, that the atmosphere assisted in the induration of the teeth.

Clopton Havers, believed the enamel to be of a stony nature, and the ivory* a bony substance; especially the root, which last, he says, is covered by a periosteum. He thought that the follicle no longer furnishes any nutriment to the enamel after it is once formed. He assures us, that he has observed with a microscope, nervous filaments coming off from the pulp, traversing the ivory and reaching the periosteum by little canals; by which anatomical arrangement he explained the sensibility of the teeth.

Verheyen, in consequence of the analogy which he supposed to exist between the teeth and the hair, thought, as was then believed, that they increased, indefinitely, even after death.

* Throughout the treatise, it will be found that this word is used to designate what is understood in our dental works as the bony portion of the tooth. It will be seen, that it was necessary to retain the word in this sense, as the author includes in his definition of a tooth, both the investing and lining membranes, which he calls the follicle, and the tooth proper, which he calls the bony portion, and divides the latter into the ivory and enamel.
Translator.

Raw, it is said, has stated that the permanent incisors are situated posteriorly to the corresponding milk teeth, that the canine permanent teeth, on the contrary, are placed in front of those which precede them; and that the secondary molares are situated immediately under the deciduous teeth of this class. From this supposed arrangement, he advised, when the temporary teeth remained after the permanent teeth had made their appearance, the extraction of the anterior for the incisors, and the posterior for the canine teeth.

Tenn, in a thesis, sustained under the presidency of Sigismondi, has said nothing worthy of notice with regard to the teeth; he renewed only the old belief that worms were developed in the internal cavity, and caused violent pain.

Sermes, in a letter published in the "Ephemerides Germaniques," gives an account of a dinner which he gave to a number of physicians. Amongst whom was Averduin, where the following question was raised: "What becomes of the roots of the temporary teeth?" Some contended that they were destroyed, others that they never existed. Sermes believed with the former, and attributed their destruction to the action of the permanent teeth; he offered, in support of his opinion, an instance of a temporary tooth which was destroyed only on the side where it was affected by the pressure of the rising permanent tooth. He said, that the dental follicle appeared to him to be a dependence of the gum, *(hæc bursula mihi videtur a gingivas mutuata; si enim avell gingivas, simul extraho bursulam illam cum denté, etc.)*

Christian Schwardt, in a dissertation, upon the *dentes sapientiæ*, gives a good description of the teeth, and indicates a number of disorders to which they give rise; he says, also, that in his time, those who were born with teeth were regarded as having a cruel and tyrannical disposition, *(an hæc res crudelitatis, uti vulgo opinatur, et tyrannidis fuerit indicium, etc.)*

Fouchard, in his treatise upon the teeth, entitled the *Chirurgien Dentiste*, has presented nothing new; he was contented to recapitulate what had been said by those who preceded him; he called the little membrane, which surrounds the embryo tooth, the *choroïd*, and relates an instance of third dentition.

Diechmann sustained his inaugural thesis in 1737, upon the

wisdom teeth, and commenced by criticising the definition itself; for, said he, *minime sapientiam adaugent, nec adferunt, et ubi nulla adest, ibi hisce dentibus non introducitur.* We believe this without difficulty, but has he understood the true meaning, the philosophical intention of this designation? He relates some interesting cases of retarded dentition, and cites an instance, mentioned by Pliny, of a man one hundred and four years of age, whose teeth were reproduced. He thought that the teeth increased continually, and were worn away in the same proportion, until the period of old age, when this equilibrium of organization was no longer kept up.

Ungebaur, in a thesis upon second dentition, sustained under the presidency of d'Hebenstreit, in 1738, has distinguished himself by some new and ingenious views which he presented. He compared the tooth to an egg, and said that the bony laminæ were formed successively, from the circumference to the centre: *antè omnia crusta ossea dentibus inducitur, sub quâ non aliter ac testæ ovorum albumen continent, mollis aliquis mucus stabulatur qui paulatim laminarum more a peripheriâ versus centrum condensatur.* I do not wish it to be understood that I sanction this view of the formation of the teeth, I am at present only acting in the capacity of a historian. He says, the tooth is primitively entirely enclosed in the capsule of the follicle, which, in developing itself, it ruptures. He believed that there exists a coincidence between the disappearance of the processes of the bones and the last periods of dentition: *(coïncidit adeoque totius dentitionis negotium cum apophysibus totius corporis obolitis, etc.)*

Ungebaur has, also, described the *iter dentis*, in a manner which no longer leaves any doubt upon the subject; but we will let him speak for himself: *(quod si inspicias maxillas infantum, quibus primores dentes nondum effluxerunt, a tergo primæ dentium sirici videre licet foramen per maxillam hians valde parvum, per quod folliculi dentem comprehendentis portio ad periosteum externum et gingivas tendit.* If it were not very evident that Fallopius considered the prolongation of the follicle which he named *cauda*, was hollow, this same question is not admissible for Ungebaur; nothing is more evident than this deduction.

Kornmann states, that, in the time of Tiberius, bodies were discovered in Sicily, belonging to the human species, having teeth a foot long.

Godfrey Jancke published a dissertation upon the teeth, in 1751, of which I will present, in a few words, all that appears to me worthy of notice. He said, that the large molars appear to be formed by an union of four canine teeth; he offers for a reason why the alveolar border of the lower jaw is thrown inward, that the permanent are situated on a plane posterior to the deciduous teeth; he indicated the remarkable hardness—almost cartilaginous—of the gums, before the first dentition; he described the form of the alveoli, the relations which they bear to the teeth, and the modifications which the jaws undergo in consequence of the development of the latter. He believed that the fall of the deciduous teeth was to be explained by the fact of the obliteration of their vessels by the compression of the permanent teeth. (*Cadunt igitur circâ annum septimum, quia eâ, ætate circiter, tantam magnitudinem secundi dentes acquirunt, ut priorum vasa comprimendo claudere queant.*)

Ludwig, in a dissertation, entitled *De Cortice Dentium*, devotes his attention particularly to the structure of the enamel. He asserts that this substance is of a fibrous nature, attempts to indicate the direction of the fibres in many points of the crown, and says that they are implanted upon the ivory; he has objected, very justly, to the opinion that exposure to the atmosphere is necessary to the completion of the enamel, that, upon a tooth found in the thickness of the palatine process of the superior maxillary bone, and consequently sheltered from all action of external agents, the enamel was as well formed as upon the other teeth.

Bertin has described the teeth very fully, in his treatise upon osteology, and has advanced an opinion with regard to the enamel, which I will mention: "It has always appeared to me," he says, (p. 242,) "that the enamel which covers the crown of the tooth, notwithstanding the contrary opinion of most authors, is extended also upon the root, but that it gradually diminishes in thickness from the crown to the extremity of the root." He indicated, also, a third substance, that, he says, fills up the

cavity of the tooth, and is the production of a lymphatic juice, which has become thickened without acquiring a bony consistence. "This," he adds, "is what I call the third substance of the tooth, differing from the ivory and enamel," &c. He said, also, that this substance sometimes formed a bony shell, distinct from the ivory and enamel, but which, however, at length identifies itself with the former. He explained the mechanism of the eruption of the tooth in this manner: he said that the root, finding an invincible resistance in the bottom of the alveolus, was carried towards the gum, which it perforated. The great pain and convulsions which are often attendant upon first dentition, arise, according to this author, from the pressure exercised upon the nerves at the bottom of the cavity, caused by the resistance of the gums. The treatise of Bertin is undoubtedly the best which I have noticed up to this period.

We find, in the "*Mémoires de l'Académie des Sciences*," a paper by Herissant, upon the formation of the enamel and the disposition of the gums. He admits the existence of two species of gum, the one temporary, the other permanent. The temporary gum, according to Herissant, is of a tough, leathery consistence, covering the whole upper border of the alveolar arch, before the eruption of the teeth, for the purpose of closing the sockets, and is destroyed, in lamellæ, by a kind of exfoliation, when the teeth pass through it. According to this author, also, the sac which contains the dental follicle is a prolongation of the temporary gum, and the drawing he gives of it resembles, very closely, those which represent the *iter dentis*. He thought, too, that this sac secretes the enamel, and that its surface is covered with an infinite number of little vesicles, filled with a fluid which forms this substance by concretion. He adds, "We are no longer at a loss to understand by what mechanism the crown of the tooth is, little by little, plastered over with this fluid enamel. What has been said of the destruction of the sac, which takes place at the same time, and in proportion as the crown of the tooth issues from the alveolus, is understood, for all the adhesions of the internal surface of the membrane with the crown are then ruptured, and the vesicles which contain the enamel are broken up; thus the liquid is poured out upon

each portion of the crown, preparatory to its eruption." Herissant has indicated, then, in this paper, the fibro-cartilaginous gum and the *iter dentis*, and has offered a new exposition of the formation of the enamel; more has been said by him, that tends towards the advancement of the science, in a few lines, than is contained in the enormous volumes of some other authors.

Haller has treated, with the superiority for which he is so eminent, of the development and structure of the teeth; he did not, it is true, make any important discoveries, but he has, undoubtedly, given the most philosophical exposition of the subject, and one of the most elevated order, of any author of his time. What he has said with regard to the arteries of the teeth is original.

Lassone, also, devoted much attention to the subject of dentition, and has left a long dissertation. He believed he had discovered a cartilaginous substance, which is placed between substance is secreted this membrance make an immediate enthe alveolus and root of the tooth, forming a sort of intermediate partition, and adhering equally to both. He was not satisfied, however, that this is a real cartilage, but supposed, rather, that it is the periosteum itself, thickened by compression.

Bourdet, in a paper placed amongst those of the Academy of Sciences, states, that he detected, in large animals, the little vesicles destined to secrete the enamel, and confirmed the discoveries of Herissant.

Spallanzani, in his first researches upon the properties of the gastric juice, asserts that that of a dog possesses the property of corroding the vitreous substance of the teeth.

De la Fière, the younger, advanced the opinion, that the fibres of the enamel are developed very much like those of the nail, for he supposed them both to be of a fibrous nature.

Jourdain, in his essay upon the formation of the teeth, describes, minutely, the dental follicle, and traces it, in all its successive evolutions, from its first appearance up to the period of birth. He describes also, two canals in the inferior jaw of the fœtus, one of which, a semicircular furrow, is destined to give passage to the vessels and nerves of the deciduous teeth; the other, which is a true canal, for the passage of the same parts to the permanent teeth. This long paper, devoted entirely to

the consideration of the development of the teeth, possesses great interest, because we clearly perceive that the author speaks only *de visu*, and that what he has said is the result of observation.

Albinus has, also, described, with much exactitude, the development and structure of the teeth, and has presented a recapitulation of all the facts which enriched the science up to his time. He added to this his own knowledge of the subject, and the result of his own observations. He makes mention of two teeth which were found buried in the nasal process of the superior maxillary bone, in an inverted position, the crowns being directed upwards; they were of the canine class, and of considerable length and size, whilst those occupying the usual position of these teeth in the alveolar arch, were very small. From this fact, Albinus supposed, and not without some appearance of reason, that the anomalous teeth were the true permanent canines, whilst those which occupied their place in the arch of the alveoli, were of the temporary set, and had never been shed.

In a treatise, entitled "*Historia Naturalis Dentium Humanarum*," translated by Boddaert, (1761,) the celebrated Hunter has presented an anatomical history of the teeth, with an order and clearness unknown before his time; and has given the result of a great number of experiments made by him, for the purpose of elucidating this subject. He said that the enamel, which he called the *lamina vitrea*, is composed of striæ, directed from the circumference to the centre; he believed it to be entirely inorganic, because he was unable to convert it, by any means which he was able to employ, into an animal mucus; he separated it, by the action of heat, from the ivory. He called the ivory the bony portion of the tooth, and believed it to be analogous to the other bones. He said, however, that when madder was given to young animals, only those layers of the tooth were reddened that were forming whilst the animals were feeding upon this substance, those which were formed previously not being affected, in this respect differing from the other bones. He found, also, that the coloring matter did not pass away from the tooth, when it was once impregnated with it, but that it retained the red color ever afterwards; from which facts he drew the follow-

ing general conclusions: *ex his experimentis patet dentes considerari debere ut corpora anomala respectu circulationis per eorum substantiam.*

Continuing his description, Hunter thought that the root is surrounded by a periosteum, which comes off from the alveolus and is extended into the cavity of the tooth; that the ivory is formed of concentric lamellæ; that the ossification of the incisors commences by three points, the canines by one, and the molares by three or four; that the tooth, from the moment of its eruption, becomes a foreign body in relation to the gums; that the enamel is probably secreted by the capsule which invests the crown of the forming tooth; and he adds: *Post secretionem terrea pars attrahitur a parte osseâ dentis jam formati atque superficie crystallisatur.*

He also said, that the deciduous teeth fell by a law of the organization and not by the mechanical action of the permanent teeth. If it be considered that the treatise in question is developed with talent, and founded upon observation, some idea may be formed of its importance.

Courtois said that it was not necessary to be very careful in filing the teeth, to preserve the enamel, as this substance was usually reproduced with facility. I will here mention a fact related by Cook, in his first voyage, (*trad. dans la Biblioth. portative des voy.*) He says, that certain people of the Indies, are in the habit of rubbing down the free edges of the teeth, with a stone, until they are perfectly equal and polished, and that they hollowed, in the middle of these teeth, a furrow, parallel to the gum, of a depth equal to a fourth of the thickness of the tooth, but that notwithstanding this rough usage, not one of these Indians had decayed teeth; he did not say, however, that this furrow was effaced by a new deposition of enamel.

Auzebi, a dentist of Lyons, in a treatise upon odontology, has had the presumption to controvert all that had been advanced before him, with regard to the germ of the tooth. He has denied all, and contented himself with saying that the vessels and nerves of the part, spread themselves upon a little musculo-membranous vesicle, which has been erroneously taken for the germ. He attempts then, in a long and fastidious explanation,

to give his ideas of the evolution of the teeth; but it is impossible to follow him, he is unintelligible. He calls this revery, however, a new theory, and the only true one founded upon direct observation.

Sabatier stated that the diversity of the sensibility of the teeth, depends upon the nature of the openings in the extremities of the roots, which are sometimes obliterated, especially in advanced age, so that the dental nerves are entirely cut off, and are no longer continuous with the trunk from which they take their origin.

Wooffendale was the first to notice an anatomical peculiarity, which it seems to me I should mention here, not that I look upon it as a very rare thing, but because it is a fact which demands another interpretation than that which is given to it. He says, we often see upon the teeth little yellow spots, which resemble holes gnawed by worms; and their occurrence was more frequent at the time he wrote, in consequence of the custom which then prevailed of inoculating children for the small pox, before the formation of the teeth was completed. He attributed the appearance of these little yellow spots to the small pox, and said that they were always less marked if the disease had been contracted either a short time after birth, when this development of the teeth is but little advanced, or at such a length of time after, that the formation of the teeth is nearly completed. He states, also, that the teeth, affected in this manner, make their appearance later than the others. He remarked, also, that in jaundice, the enamel takes a slightly yellow tinge, from which fact he concluded that it was endowed with lymphatic vessels. This is about the amount of what his treatise upon the teeth offers, that is worthy of attention. He observed many cases of supernumerary teeth.

Broussonnet wrote a treatise upon the teeth, of such merit as to attract the attention of the *Academy of Sciences*. It is devoted to a consideration of the teeth in general, and the organs connected with them; the author made many excursions in the field of comparative anatomy. This dissertation is remarkable for reflections, which, if they are not always ingenious, are at least marked with the stamp of originality.

Tenon has also offered a paper deservedly esteemed, upon the subject before us; but as it is devoted to comparative anatomy and particularly the teeth of the horse, and as I shall have occasion to refer to it many times, with distinction, in the course of this treatise, I shall be contented with merely citing him now, without attempting to develope the opinions he has advanced.

This period, it has been seen, presents a great number of works, and although I have noticed a great many, I have not touched upon the tenth part, which, during this time, was written upon the teeth. To avoid overcharging this work, and fatiguing the reader with an useless display of erudition, always easy when libraries are at one's disposal, I believed it my duty to confine myself to those authors that have distinguished themselves by the originality of their views, or their reconcilement of differences. Without having adopted such a course, this volume would have been of double the size, and one half would have been but an insipid catalogue. Indeed nearly the whole of those authors I have passed by in silence, have offered but idle repetitions and compilations without end, which had not always, even the merit of being exact and faithful. Let us now pass to the sixth period.

PERIOD VI.

FROM BICHAT TO THE PRESENT TIME.

Although I shall have fewer authors to mention in this last period, than in the one preceding, it must not be supposed on this account, that the anatomy of the teeth has made but little progress; on the contrary, all the phenomena of the development of the teeth, have been described with a rare precision, and errors which time had consecrated, have been combatted and overturned. When an error is exposed, a step is made forwards in the way of truth. Many truths which, from neglect and prejudice, were abandoned, have been drawn from their unjust se-

clusion, and elevated to the rank of fundamental principles, and many things which escaped the observation of our predecessors, have been discovered under the intelligent scalpel of some modern authors.

Bichat, the first in order, has, I regret to say, given but little attention to a subject so worthy the attention of a man of his sagacity; and has done but little toward the advancement of the anatomy of the teeth. He starts out, indeed, in his consideration of the subject, with a doubt, which he makes no effort to clear up; he asks, is the enamel organized, or is it only a liquid secreted upon the surface of a tooth, where it concretes and hardens? His answer is but a doubt, and his mind generally so ardent and so impatient, to trace things to their depth, is contented, in this instance, to remain at the surface. But when he comes to the functions of the teeth, and their sympathetic connections, Bichat is himself again, he seizes his subject and masters it, searching out with his eagle glance, its most hidden relations. "There is often," says he, "a sympathy existing between the corresponding teeth of the same or of the opposite jaws. I have a great molaris of the left side a little carious, which sometimes causes much pain, and I have always observed that the first molaris of the right side, at such times, although it was perfectly sound, became painful." In other cases, where the disease existed in the lower jaw, the sympathetic pain manifested itself in the superior jaw, and reciprocally. He compares the sac which envelopes the pulp to a serous membrane. He believed that, in the eruption of the teeth, there is something more than a simple elevation of the gum, but he acknowledges that he does not comprehend the true mechanism.

In an article upon the phenomena which take place subsequent to the appearance of the second teeth, Bichat says, that after their eruption, they increase manifestly, both in length and thickness. The root only grows in length after the eruption of the teeth, the crown always preserving the same external dimensions, and if in old persons they present the appearance of being elongated, it is only on account of the absorption of the gums. The same phenomenon is also observed in those who are emaciated, and in persons who have made an excessive use

of mercury. Bichat adds: "The increase of the tooth in thickness does not take place externally, but is caused by the filling up of the dental canal, which gradually growing smaller, is at last entirely obliterated. When this occurs, the teeth no longer supplied with blood and nervous fluid, are deprived of life and fall out; but this death is also caused by the excessive accumulation of phosphate of lime, which becomes so predominant over the gelatinous constituent of the teeth, that the principle of life is, as it were, suffocated; under this relation, the fall of the teeth presents phenomena analogous to the shedding of the horns of herbiverous animals, and the calcareous covering of the crustaceæ." He asks, why nature has accorded to the teeth a term of life, shorter than that of the other bones, which cease to exist only with life, and here he acknowledges himself unable to make a satisfactory reply.

I should have done with this historical period, what I did for the preceding, have noticed, successively, the works which had been published upon the subject, or at least the most important of them, and have given in a few words the views of each author, or what he had contributed to the science, but as it is particularly from these authors, that I shall draw principally the material of the following dissertation, I shall not speak of them here, to avoid waste of time, and a tedious repetition. I will say only a few words of *Lavagna*, an Italian author, of whose work I have made a translation, as it appears to me, that he had made some curious experiments, and has opened the way to researches of the highest importance. And, indeed, in his treatise entitled "Experiments and Reflections upon Caries of the Human Teeth, and upon the reproduction of the teeth of the *rodentia*," Lavagna described caries of the teeth, and advanced a new theory, founded upon experiments, to explain the cause of its occurrence, and pointed out its most frequent seat. He mentions a series of experiments, which he made upon the teeth of the *rodentia*, and from which he drew the conclusion that they grew indefinitely, having broken off, indeed, considerable portions of their teeth, he saw them reproduced. His experiments are happily conceived, the conclusions which he draws from them, appear natural, and his whole work justly merits the unanimous encomiums of

the Medical Society of Emulation of Geneva, which it received. Having established a learned analogy, he draws conclusions, of which the following are the most important. "We see, in the first place, that the human nails, the hoof of quadrupeds, the beaks and claws of birds, the scales of fishes, &c., increase continually, as do, also, the teeth of the *rodentia*, if no external cause occurs to prevent it: (si osserva in primo luogo, che le unghie umane, le scarpe dei quadrupedi, il becco et gli artigle degli uccelli, i capelli, le pinne dei pesci, ec, si allungano, si destendono continuamente, siccome i denti dei rosicanti, se qualche exteriore cagione non si oppone alla loro perenne vegetazione, etc.)

PART II.

ANATOMY OF THE DENTAL SYSTEM.

CLASS I.

OF THE TEETH IN GENERAL.

In entering upon an anatomical history of the teeth, considered in relation to the whole of the animal kingdom, it seems desirable that a certain degree of generalization should be observed, the field which presents itself, indeed, is so vast, and the divisions are so various, that without adopting a method of this kind, which at once simplifies the subject, there is great risk of confusion, or of overlooking some points of importance.

The most general idea which can be given of the teeth, at this stage of our work, is, certainly, that which represents them as resisting bodies placed at or near the entrance of the digestive canal, destined to seize and divide alimentary substances, and to serve sometimes, as means of attack and defence.

The teeth are a production of the internal tegumentary system; they are true appendages of the digestive membrane, in a depression of which they are lodged by their adherent extremities.

Independently of the constant relation of the teeth to the tegumentary system, they present another, which, although it is not so common, is of acknowledged importance, I mean that which they bear to the osseous system. Sometimes there is no manner of connection between them, but more frequently the osseous system furnishes a point of support for the teeth, either upon a surface or in special cavities, which bear the name of *alveoli*.

Generally, the teeth are arranged in series; they are all, at least, opposed by their free extremities forming pincers, more or

less pointed, cutting or flattened; without this last conformation, indeed, they would have been unable to perform those functions for which they were intended.

The dental organs, the nature of which is well known, are essentially composed of two elements, *the secreting portion*, and the *portion secreted.*

The secreting portion, the *matrix*, *follicle*, *bulb* or *germ*, is an immediate dependence of the tegumentary system, it is a little sac, analagous to the sebaceous glands, with this difference, that it gives origin in its interiòr, to a little body of variable form, which constitutes the papilla or *noyau pulpeux.* Its base is united to the adjoining parts, by a plexus of vessels and nerves, whilst its opposite extremity presents an opening, the throat of the follicle, through which the tooth is carried to the exterior; which, however, remains closed, until the eruption of the tooth takes place.

The secreted portion is the tooth, properly so called; under its organic relation, it is the secondary, but, considered in regard to its utility, the principal part. The variations of form, are so numerous, that it is impossible to describe them here; we will say only, that the tooth is composed of two parts, the crown, which is free at its extremity, and the root, which is implanted in the follicle, and generally hollowed for the reception of the papilla.

The matrix of the tooth, has the membranous organization of the teguments in general; the only thing peculiar that it presents, is the considerable growth of the papillary body, in one point. The tooth proper, is, on the contrary, composed of bony laminæ, imbedded one within the other, and which are entirely deprived of the vessels and nerves of the germ. To describe, in a few words, these two elementary portions of the teeth, it will be sufficient to say, that one is endowed with a vitality superior to that of some other organs of the body, whilst the other is entirely unorganized; the first is, a kind of gland, the second is the production.

It will be perceived from the above, that the two portions of the teeth are always formed successively, the secreting portion first, the secreted portion afterwards. The secreted portion ap-

pears in the interior of the follicle, and is developed upon the pulp by their laminæ, which are secreted internally to each other, and which are in simple juxtaposition with the pulp. It remains in the follicle, until, from its increase of size, it is no longer able to be contained within it, at which time it is carried towards the exterior. It effects its eruption, either by dilating the throat of the follicle, or by forcing a route through some other portion.

After its eruption, the tooth continues for a time of greater or less duration to increase, but always by the addition of successive layers, internally to those already existing; but then commences a work of destruction, which proceeds from the exterior to the interior, in consequence of the friction to which the tooth is exposed, in performing its proper functions.

Some teeth, the incisors of the rodentia, for instance, are capable of being reproduced, in proportion as they are worn away; but others less fortunately disposed, are delivered up, as it were, to the destructive agents, which surround them, without being furnished with any means of defence, and are destroyed after a time more or less long.

Thus has nature, by the boundaries more or less narrow, which she has placed to the growth of most of the teeth, marked the period of the existence of animals; for a time comes, when deprived of these organs, they are no longer able to seize their prey, or to effect those modifications in their food, which are necessary to prepare it for the action of the digestive fluids.

The dental system, however, possesses some means of counteracting the destructive effects of these agents, and of prolonging their duration. I have already mentioned the fact, that some teeth increase continually, by the deposition of new matter at their base, in proportion as the work of attrition goes on at the opposite extremity. But another means, not less remarkable, exists, by which the teeth that have become worn, and almost useless, are replaced by others, which are much more suitable to fulfil the necessary functions. It is principally the work of replacement, which, though, differing in mode, in the great series of animals, always takes place, that we designate by the name of dentition.

The teeth are not only important, on account of the functions they perform in the economy, they furnish to the physician and zoologist, marks for the determination of the age, the temperament, the nature and habits of animals; hence is seen the importance of carefully studying them.

CLASS II.

THE TEETH IN PARTICULAR.

CHAPTER I.—*The Human Teeth.*

Few portions of the human organism have attracted as much of the attention of anatomists as the teeth, the most hidden circumstances of their external form, of their organization, of their development, and the part they perform in the economy, have been the subject, of the most minute and satisfactory research; the varieties they present, according to the ages, races, and individuals, have also been studied with the greatest care. Thus it will be seen, that the task before me, is one remarkable for its extent and difficulties.

ORDER I.

CONFORMATION OF THE TEETH.

The teeth, as I have already remarked, are composed of two distinct portions, the *part produced*, and the *follicle*. The production of the dental follicle is ossiform, for which reason it has been called the bony portion. We have, then, to describe the bony portion and the follicle, successively in a general, and then in a particular manner.

ARTICLE I.

CONFORMATION OF THE BONY PORTION, AND THE DENTAL FOLLICLE.

SEC. 1.—*Of the Bony Portion of the Tooth.*

The bony portion of the tooth has, generally, the form of a hollow cone, free at its base, and adherent by its apex. A portion projects from the alveolus, and presents an appearance resembling, so nearly, the other bones, that it has for a long time deceived anatomists, and is, even at this day, the source of an error of the same nature. Its external surface is clearly divided into the crown, the root, and the neck.

The crown is placed without the alveolus, in continual contact with the air, the saliva, and other external agents. It differs but little with respect to length; the varieties of form, on the contrary, are according to the different classes of the teeth. The summit, turned upward or downward, according to its situation in either jaw, presents an even surface, after it has been somewhat worn by the friction of mastication only; in a new tooth it is relieved by many points. Its circumference is more rounded and projecting towards the exterior than the interior of the mouth, and the whole surface presents a fine white tint, of a very remarkable vitreous appearance.

The root is the portion which is received into the alveolus. It is longer than the crown; is sometimes simple, and sometimes divided into two or more portions; this division is frequently only traced upon the root, and is not completely effected. Its form is that of an irregular cone, the base of which is attached to the adherent part of the crown; the apex or apices are pierced with an opening or openings, which transmit the vessels and nerves to the central cavity of the tooth. Its surface presents a yellowish tint, in contrast with that of the crown. In the recent state, it is united, in an intimate manner, to the alveolar wall, by means of the membrane of the dental follicle.

The neck is represented by the point of junction between the crown and the root, and is the place where the vitreous substance of the crown ceases. The neck is often marked with

two curved lines, the convexity of which is turned towards the root, and which unite at an angle upon the sides. It is intimately united, in the recent state, to the throat of the dental follicle, and the tissue of the gum, which is continuous with the latter.

The interior of the bony portion of the tooth is hollowed into a cavity, which extends from a level with the neck to the centre of the crown. This cavity takes very nearly the form of the tooth itself; it is closed towards the crown, but is prolonged into the root, gradually growing more and more narrow as it approaches the extremity, where it terminates in the little foramen mentioned above. The dental cavity prolongs itself into each root, when there are more than one, and serves to afford a lodgment to the papilla.

Sec. 2.—*The Dental Follicle.*

The dental follicle, the soft or pulpy portion of the tooth, (*pulpe centrale*, Cuvier,) is the part by which the tooth is produced, and is one of the means of its union with the alveolus. It is a sac, very analogous to the follicles which serve as matrices for the production of the hair and feathers of birds.

The dental follicles are placed in the alveoli, and are equal in number to the teeth; they are little sacs, formed by depressions of the mucous membrane from the level of the neck of the tooth. Exteriorly, they are united intimately to the alveolar periosteum, and are adapted to all the anfractuosities of these cavities. At the bottom of the alveolus, the external coat of the dental follicle receives its vessels and nerves.

Interiorly, the follicle of the fully developed tooth, to a description of which I shall now confine myself, is filled by the root of the tooth, to which it adheres intimately; its throat, or buccal opening, embraces and is firmly attached to the neck of the tooth; its base gives origin to the papilla, or central pulp, (*noyau pulpeux.*)

The papilla is analogous to those of the hair and feathers; it is a mucous papilla, which, at this particular point, has taken a

considerable development, to become an organ of secretion; it is lodged in the cavity of the tooth. Its volume is in inverse proportion to the age of the individual; its form is exactly that of the tooth, from a level with the neck of which it swells out into the crown, where it terminates in as many points as the latter presents externally. It is inserted upon the bottom of the follicle, of which it makes a part, by means of one or more thin pedicles, which traverse the root or roots, and the foramina which they present at their extremities. It is of a grayish color, has all the softness of mucous fungosities, and is endowed with an exquisite degree of sensibility.

M. Serres described, twenty years since, a series of little bodies, which he called *dental glands*, that are disposed in a circle upon the edge of the alveolus, around the throat of the follicle. These bodies are themselves little follicles, which secrete a substance destined to lubricate the surfaces of the alveoli, previously to the eruption of the teeth, and which, according to the anatomist I have cited, afterwards form the tartar upon them. M. Serres compares them to the Meibomian glands; but they appear to me, rather, analogous to the follicles which are found around the throats of the matrices of the hair.

The dental glands have been observed by M. Rousseau; but this anatomist assures us, that they disappear after the eruption of the teeth, and that, consequently, it is impossible to attribute to them the secretion of the tartar, which continues during life. This point of dental anatomy is very obscure, and more light is needed to enable us to come to any positive conclusions; I believe myself able to affirm, however, from my own observation, that follicles do exist around the necks of the teeth of adult individuals.

It is plain, from what has just been shown, that a close analogy exists between the dental follicle and that of the hair and feathers. Both organs are formed by a reflection of the mucous membrane; both are united to the adjoining parts by a nervous and vascular pedicle; both have a narrow throat, adhering to the body which they produce, and surrounded by a follicular circle; both give origin to a papilla at their base; both, finally, enclose, the former the tooth, and the latter the hair or

the feather. The only very sensible differences which exist between these two parts, consist in these: the dental follicle is mucous, whilst piliferous and penniferous follicles are generally cutaneous; the first is enclosed in the alveolus, whilst the latter are plunged in the general cellular tissue; and the dental follicle is pediculated, whilst the piliferous follicle, particularly, is sessile. It will be seen, presently, that this last difference implicates the limited growth of the teeth and the indefinite increase of the hair.

ARTICLE II.

PARTICULAR CONFORMATION OF THE TEETH.

At the time of the complete development of the organization, a period which I have taken as the type of my description, we find thirty-two teeth, sixteen in each jaw, placed upon a parabolic line, the convexity of which presents anteriorly, the concavity posteriorly, and which constitutes the dental arch.

The teeth are disposed, symmetrically, in each jaw, upon the right and left of the median line; those of the superior differ from those of the inferior jaw, being generally more fully developed. The anterior teeth do not resemble either those situated laterally or posteriorly to them.

The differences which are observed between the *anterior*, the *lateral* and *posterior teeth*, are very important, for they are founded, not only upon their conformation and position, but upon the uses which they perform. They are properly divided into three species, the *incisor*, the *canine*, and the *molar* teeth. Let us examine, successively, their bony portion, their follicle, and the alveoli which receive them.

SEC. 1.—*The Bony Portion of the Tooth.*

Considered with regard to their external appearance only, the three classes of teeth present very marked differences in their conformation.

The incisors are eight in number, four in each jaw, in the anterior part of which they are situated, and, as their name indicates, serve, principally, to cut or divide the food.

The crowns of the incisor teeth are wedge-shaped, and compressed antero-posteriorly. Their anterior face is convex, their posterior concave; the lateral faces are plane and triangular. The free extremities form cutting edges, and present three unequal elevations, the middle of which are greatest. The roots are simple, compressed laterally, and sometimes marked with a longitudinal furrow upon their sides. The extremities are sometimes bifid. The internal cavities are generally simple.

It is unnecessary to repeat, that the superior are larger than the inferior incisors; it is a fact I have already indicated, and which, indeed, is not peculiar to the incisor teeth of the superior maxilla. I will mention, here, however, that the superior central, are larger than the lateral incisors; the reverse of which is the case in the inferior jaw.

The canine teeth are four in number, two in each jaw, and situated next to the lateral incisors.

These teeth, as their name indicates, are destined to tear the food; they have a conical crown, convex outwardly, and a little compressed within; it terminates in a sharp point, somewhat elevated above the level of the other teeth. Their root is long, large, always simple, and less flattened, laterally, than those of the incisors; the cavity is simple.

The molar teeth are more numerous, and situated more posteriorly, than the others; there are twenty, ten in each jaw. They are destined to grind the food, as their name implies.

These teeth are remarkable for the flat surface presented by the summit of their crown. This part is little elevated, rounded or square, and terminates by points, which are never found singly upon these teeth, from which cause they take their name multicuspides. Their roots are generally compound, the divisions of which are either entirely separated, or joined together by a deposition of bony matter between them. Their internal cavity, simple in the crown, is divided, in the root, into as many portions as there are divisions of the latter. The conformation

of the bony portion of these teeth makes a division into two species necessary, the large and small molars.

The small, or bicuspides, are situated before the large molares, and next to the canine teeth. Their crowns are a little compressed antero-posteriorly, of small size compared with the multicuspides, and are terminated by two points, one placed towards the inside of the mouth, the other, which is more elevated, towards the outside. Their roots are sometimes simple, and sometimes more or less deeply divided.

The large molars, or the multicuspides, are the largest and strongest of all the teeth. Their crowns are quadrilateral, very large, comparatively, and surmounted by three, four or five tubercles. Their roots are always compound, but there is considerable variation in the degree of convergence and divergence of the different divisions. The first great molars, proceeding from before backwards, is the largest; the second and third diminish gradually in size. The third great molars is called the wisdom tooth, in consequence of the advanced period of life at which it makes its appearance.

An exception to the general rule, I mentioned above, obtains here: the superior great molars are not so large as the molars of the inferior jaw; it holds good, however, with regard to their roots.

Sec. 2.—*The Dental Follicle.*

The follicle, as may be supposed, is not similar in all the species of teeth, as this part is the matrix of the tooth, properly so called, which is, as it were, moulded upon the papilla.

Independently of differences of size, which are always in proportion to the volume of the tooth, the dental follicle presents others of more importance.

The sac of the follicle of the incisors and canine teeth is simple, like the alveoli in which they are enclosed; that of the follicle of the molars, on the contrary, is sub-divided into a number of secondary follicles.

The papilla is uni-pediculated in the anterior and lateral teeth and multi-pediculated in the molars. Its upper extremity is sur-

mounted by as many eminences as there are tubercles to the crown of the multicuspid tooth.

Sec. 3.—*Of the Alveoli and the Dental Arches.*

The teeth are placed in special cavities, hollowed in the corresponding borders of the maxillary bones, which belong to a particular portion of the jaws, called alveolar processes.

The alveoli are conical and more or less sub-divided, as the roots of the teeth, which they receive, are more or less compound. Their openings are directed upward in the inferior and downward in the superior jaw; their bases are pierced with small foramina which give passage to the nerves and vessels destined to supply the dental follicles.

The alveoli are exactly embraced by the two plates of the alveolar processes, insomuch that they stand out in sensible relief, anterior and without the surface of the jaw. They are, in size, proportionate to the teeth which fill them; small, for the incisors, a little larger for the canine, and largest for the great molars.

The teeth are received into the alveoli like a nail driven into a piece of wood; this species of union received the name of *gomphosis* at a time when the teeth were regarded as bones, and their articulation with the jaw as analogous to that of the joints.

The walls of the dental follicle are confounded externally with the alveolar periosteum; this forms their only means of union with the alveolar processes in a normal condition.

It is sometimes the case, however, that the teeth are more firmly retained in their sockets than by this union, in consequence of the curved form of their roots; thus the molars sometimes divide, and making an outward curve, are fixed strongly in the bone: offering a great degree of resistance. Sometimes, on the contrary, the roots of the same teeth converge, and we find an osseous body between them, which is so closely attached as to be almost inseparable from the tooth.

The teeth and their alveoli form, upon the two jaws, an uninterrupted series, which constitute the dental or alveolar arches.

These arches have an elliptical form; their convexity presents outwardly in the direction of the lips and cheeks, their concavity inwardly towards the tongue; their direction is sensibly horizontal.

The superior is a little greater in its extent than the inferior dental arch; it projects in such a manner that the superior incisors and canine teeth close over those of the under jaw like the blades of a pair of scissors. The depressions and elevations upon the crowns of the molar teeth of the two jaws are perfectly adapted to each other.

ORDER II.

ORGANIZATION OF THE TEETH.

The necessity of examining, separately, the osseous and follicular portions of the teeth, is felt more sensibly at this point of our progress than in the preceding pages; indeed, without anticipating the important question of the degree of vitality of the former, it is very evident that a great difference exists between the two parts, a difference which will be better appreciated when we come to understand their relative situation.

ARTICLE I.

ORGANIZATION OF THE OSSEOUS PORTION OF THE TEETH.

The bony portion of the teeth is formed by the union of two very distinct substances—the *ivory* and the *enamel.* Bertin and M. Rousseau, *préparateur* to the Museum of Natural History, have described a third substance which is deposited in the dental cavity, which it at last fills up, destroying, gradually, the papilla. Bertin made his observations upon the human subject and M. Rousseau upon numerous animals. M. Rousseau found it co-existent with the papilla of a perfectly healthy molar, which had become painful on account of the pressure exercised by this substance. It is said to present itself in the form of little grains

placed confusedly in a sort of mortar or stalagmite. But, notwithstanding the authority of these anatomists, I do not think the admission of this third substance is justified by the facts known. I have myself observed the formation spoken of by Bertin; but it did not appear to me to be any thing else, in some instances, than an altered secretion of the papilla, and in others, but an ossification or petrifaction of the papilla itself.

Be this as it may, the two essential elements of the osseous portion of the tooth are the ivory and enamel.

The ivory alone constitutes nearly the whole of the tooth; it forms, exclusively, the root and the central part of the crown. Its fracture presents a white color, similar in appearance to satin; neither fibres nor cells can be distinguished. It is made up of lamellæ, one within another, and parallel to the external surface of the tooth.

The ivory is of considerable density; treated with dilute nitric acid, it undergoes the same changes produced upon the bones when exposed to this agent. The calcareous portion is taken up, and a flexible mass, of a homogeneous appearance, remains, which may be reduced by digestion to gelatin. When exposed to the action of the fire, it blackens, burns, and leaves a friable residue.

According to Berzelius, this substance is composed, in 100 parts, of—

Phosphate of lime, . . .	61.95
Fluate of lime, ...	2.10
Phosphate of magnesia, . .	1.05
Carbonate of magnesia, . .	5.30
Soda and chloride of soda, . .	1.40
Animal matter and water, . .	28.00*

* The analysis of Berzelius, which follows, as given in the work of Mr. Thomas Bell, differs from the above, which is evidently erroneous.

Phosphate of lime, . . .	62.0
Fluate of lime, ...	2.0
Carbonate of lime, . . .	5.5
Phosphate of magnesia, . .	1.0
Soda and muriate of soda, . .	1.5
Gelatine and water, . . .	28.0
	100.0

Translator.

According to Pepys, the roots of the teeth afford, in 100 parts—

Phosphate of lime, . . .	58.
Carbonate of lime, . . .	4.
Animal matter, ...	28.
Water and loss, ...	10.

Morichini announced, in 1802, the presence of fluate of lime in the ivory of the teeth, but Berzelius is the only chemist that agrees with him. Fourcroy, Vauqelin, Wollaston, and Brandt have sought, without success, for this salt.

The enamel, the vitreous, or cortical substance, is limited to the crown of the tooth, according to most anatomists. Bertin, only, contends that an extremely thin lamina is, also, extended over all the surface of the root. It is thickest upon the extremity of the crown, and particularly upon the points which surmount it; it becomes thinner at the neck of the tooth, where it terminates in an undulated line; this fact, however, has been questioned.

The enamel is of a milky whiteness, and presents a vitreous appearance. It is extremely hard, and will produce fire when struck against steel. Its fracture is fibrous, and its fibres rise perpendicularly, or a little obliquely, from the exterior surface of the ivory, and resemble the pile of velvet. It dissolves almost entirely in nitric acid; in the fire it blackens and becomes friable.

According to Berzelius, it is composed, in 100 parts, of—

Phosphate of lime, . . .	85.3
Carbonate of lime, . . .	8.0
Phosphate of magnesia, . .	1.5
Animal matter and water, . .	20.0*

* This statement, also, is strangely inaccurate. The analysis of the enamel by Berzelius, as given in Sands' work, mentioned above, is—

Phosphate of lime, . . .	85.3
Fluate of lime, ...	3.2
Carbonate of lime, . . .	8.0
Phosphate of magnesia, . .	1.5
Soda and muriate of soda, . .	1.0
Animal matter and water, . .	1.0
	100.0

Translator.

Pepys has found it to consist of—

Phosphate of lime, . . .	78.
Carbonate of lime, . . .	6.
Water and loss, ...	16.

The enamel, as will be perceived from the above analyses, differs very much from the ivory; it is almost entirely calcareous, whilst the latter contains some animal matter analogous to that of the bones.

Between the enamel and the ivory there is a greyish line which has been perfectly described by Cuvier, and upon the importance of which, Doctor Duval has lately, with much reason, insisted. This line, at the neck of the tooth, is continuous with the internal lamina of the follicle which adheres to the root of the tooth. Cuvier, in his magnificent work upon fossil bones, with regard to this substance, says: "Beside the osseous substance and the enamel, there is still a very fine membrane which I believe I have discovered. Before any portion of the bony substance is secreted, this membrane makes an immediate envelope for the papilla, which it embraces very closely. In proportion as the pulp is separated from this substance, it shortens, retires within, and is separated from the membrane, which serves always as a tunic, but as a tunic common to it and the matter secreted underneath. The enamel produced by the internal lamina is now of the follicle deposited upon this tunic, which it compresses to such a degree against the internal or osseous substance, that it soon becomes imperceptible, except when the tooth is broken at a very fine thin greyish line, which separates the enamel from the bony substance. It must be perceived that this membrane is the only means of connection between the hard parts and the follicle, for without it there would be a solution of continuity."

The relative arrangement of the enamel and the ivory may be compared to that of the extremities of the bones and the cartilages of the articulations; parts which have been equally disposed to support pressure and frequently repeated frictions. Not only are the fibres of the enamel implanted perpendicularly upon the ivory as the cartilage upon the bones, but their membrane is

placed between them similar to the synovial membrane, which is interposed between the bones and the cartilage; this, at least, is the result of researches to which I have for some time devoted myself, and which I announced in my last anatomical course.

The analogy with regard to structure is equally apparent between horny substances, that of the hair for example, and the ivory of the teeth. This analogy, besides, as has been seen, was recognised by Aristotle, in whose works we find the germ of almost all the great ideas which have been developed since his time. The ivory is formed of concentric laminæ, as the horny portions of the hair, it rests upon a papilla, as the latter is placed upon a papilla which belongs to it, and finally it grows in the same manner, as will be presently seen.

ARTICLE II.

ORGANIZATION OF THE FOLLICLE OF THE FULLY DEVELOPED TOOTH.

Closely embraced between the root of the tooth and the wall of the alveolus, in the adult, the dental follicle becomes so thin and adheres so closely to both parts that it is traced with difficulty in all its extent.

At this time, however, its continuity with the mucous membrane of the mouth is perfectly apparent. It is formed of two membranous lamellæ; the external of which is fibrous, and connected intimately with the proper periosteum of the alveolus; the internal is more vascular than the other, and adheres to the root of the tooth from the extremity to the neck, inclusively. These two lamellæ, united, constitute the alveolo-dental periosteum of anatomists. They are sometimes separated in the extraction of the tooth, the internal lamella continuing to adhere to the root, is drawn out with it.

The organization of the papilla is not known precisely; all the positive knowledge we have with regard to it, is, that it is composed of the terminations of the dental vessels and nerves; which two organic elements exist in sensibly equal proportions.

The teeth receive their vessels from two distinct sources, according as they go to the wall of the follicle or to the papilla.

The vessels of the dental follicle come from those of the mucous membrane of the gums. Their principal trunks are placed on the side of the throat of the follicle, at the neck of the tooth, whilst their anastomosing branches are directed towards the base.

The vessels of the papilla are those which form the pedicle of the follicle. They have their origin from special trunks lodged in canals of the maxillary bones. These vessels do not anastomose with the others; they are disposed in an inverse manner; their trunks correspond to the base of the follicle, and their ultimate ramifications to the extremity of the pulp, and they, consequently, reach a point above the level of the neck of the tooth.

The dental arteries and veins are easily found and injected; but I do not know that any one has ever demonstrated the lymphatics of these organs. The assertions of Mascagni, relative to the lymphatics of the enamel, prove only that the most learned men who have observed nature herself, and who, of all others, should confine themselves to facts, are not always exempt from the tendency of light and superficial minds to take for truth the fruits of their imagination.

The dental nerves, like the vessels, are of two classes. Those of the wall of the follicle are very small and are derived from the nerves of the mucous membrane of the mouth. The others go only to the papilla, and assist in forming its pedicle.

It will be perceived that the dental vessels and nerves form two distinct systems: one to supply the exterior portion of the follicle, the other that part enclosed in the bony cavity of the tooth. The first is immediately continuous with the vascular and nervous system of the buccal membrane, the second comes from a special source. The verification of this statement may be found, daily, in the various pathological conditions of the teeth, and it seems to me to be an arrangement which has never been sufficiently insisted upon by anatomists.

The same arterial and nervous trunks supply the teeth of both jaws: the internal maxillary artery and trifacial nerve. There is only this difference with regard to the superior and inferior teeth: to the first, special branches go to the anterior and posterior, whilst to the last the same branches go to all the teeth.

The trunks of the vessels and nerves of the teeth are situated

above or below the alveoli, according as they are in the upper or lower jaw, on a level with each of these cavities. They send to the teeth one or more branches which pass through the openings at the bottom of the alveoli, form the pedicle of the follicle, and traverse the foramen, at the extremity of the root, to reach the papilla, in the substance of which they ramify.

At this point we encounter a more important question than any which has yet arisen. Do the vessels and nerves terminate in the follicle, or do they pass through it, and penetrate the bony substance of the tooth?

We will call to mind here, a fact which bears with overwhelming weight upon the discussion. It is this: no one has yet been able to distinguish either vessels or nerves in the bony substance, and all that has been advanced up to this time is mere hypothesis.*

When the teeth were regarded as entirely analogous to the bones, they were believed to be vascular, in the same degree; but, even then, more than one anatomist, who drew their conclusions from a strict observation of nature, only, held a different opinion. But anatomists, in consequence of an imperfect knowledge of the dental follicle, and the distinction which exists between it and the bony portion of the tooth, have frequently been led to take opposite positions when no difference really existed between them. Some attributing to the whole tooth what should have been considered only in relation to the follicle; others generalizing circumstances which should have been confined to the bony portion of the tooth.

At present, happily, these two anatomical elements of the teeth, the bony portion and the follicle, are so perfectly understood, that a similar confusion cannot arise; and the time appears to have come when it is proper to propose the question of the vitality of the former, to decide between the contrary theories which have been advanced and defended, with equal talent, by

* The existence of vessels in tooth-bone is no longer a matter of doubt. Subsequently to the publication of this work, Dr. C. A. Harris has, in two or three cases, by the aid of a microscope, detected them, in human teeth, charged with red blood. A microscopic view of one of which is contained in the Maryland Medical and Surgical Journal, and in the American Journal of Dental Science.—*Translator.*

Blake, Mascagni, &c., on the one hand, by Hunter and Cuvier on the other.

Those who contend for the vitality of the osseous substance of the teeth, allege—

1st. That a healthy tooth is sensitive when penetrated by an instrument to a certain depth;

2d. That acids applied to the teeth develope a peculiar sensibility: the setting of the teeth on edge;

3d. That they become colored in an animal fed with madder;

4th. That superficial caries cause a very lively degree of sensibility in the diseased tooth;

5th. That fractures or solutions of continuity of the teeth are perfectly repaired;

6th. That teeth which do not possess the elements of organization, as, for instance, human artificial teeth, are rapidly destroyed;

7th. That in certain diseases, as, for instance, the cholera, the teeth assume a red tinge.

But those who contend with Eustachius, Hunter, Cuvier, &c., against this doctrine, justly respond—

1st. That if, in deep wounds of the teeth, blood follows the instrument, and sharp pain is produced, it is only because the papilla has been implicated in the injury with the osseous portion, and no more proves their vitality than the bleeding of the feather of a young bird when cut across, near the skin, proves that the horny substance of the feather is vascular.

2d. That the peculiar sensation produced by the action of acids upon the teeth (setting them on edge, as it is called) may, perhaps, be explained, in accordance with the opinion of Fallopius: the acid acting directly upon the papilla, in consequence of its imbibition by the ivory.

3d. That the fact of the teeth, under certain circumstances, becoming colored, proves much more against than for their vascularity, for, if Hunter has established the fact that the teeth of an animal fed upon madder takes its red tinge, during the progress of the experiment, he has shown, also, that these parts retain their red tinge during the life of the animal, which is not the case with the bones, between which and the teeth, those

who contend for the vascularity of the latter, wish to establish an analogy.

4th. That if in slight injuries and superficial caries of the teeth, pain is developed, it is only in consequence of the partial destruction of the osseous portion which is rendered less able to protect the papilla against the action of external agents to which it is exposed, and by which, in these cases, it is painfully affected.

5th. That if fractures and other solutions of continuity are repaired, it is always effected by a secretion of the papilla, precisely in the same manner to similar injuries of the nails. And that if balls have been found in the centre of the tusks of the elephant, without any trace of the holes by which they entered, it does not prove that these holes were obliterated by a new deposition of bone from the vessels of the osseous portion of the tooth; but that the ball did not enter at or near the place where it was found lodged, but had traversed the alveolus, and found its way to its situation in the centre of the tusk through the opening at its alveolar extremity, and, coming down into the cavity of the tooth, was enclosed in osseous matter, secreted by the papilla. (Dr. Duval showed me a pathological specimen of this character, which belongs to his rich collection, and I am convinced from the examination, that the ball, in this instance, found its way into the central cavity to the base of the papilla, which, irritated by the presence of the foreign body, surrounded it with a deposition of osseous matter.)

6th. The reason why the natural teeth are not so rapidly destroyed as some kinds of artificial teeth, is, because they are (like the nails which never dry up when attached to the matrix as they do when separated from it) surrounded by parts that supply them with fluids, which keep them in their normal condition.

7th. That the red tinge which the teeth take, in certain diseases, is in consequence of a simple imbibition from within outward of the materials, which are then carried to the dental cavity by the vessels of the pulp.

I should, perhaps, confine myself, rigorously, to the facts which present themselves, and allow the reader to draw his own conclusions; but, that I may not lay myself open to the accusation

of endeavoring to avoid a difficulty by citing only the opposing arguments of the partisans of these two doctrines, I will throw myself into the discussion, and advance my own particular opinions with regard to this difficult point of odontology.

1st. It is my opinion, that the ivory and enamel of the osseous portion of the teeth are entirely destitute of vessels;

2d. I admit, with Blake, Fox, Duval, Oudet, Toirac, etc., that the osseous portion of the teeth possesses a peculiar sensibility in its superficial laminæ, which is most apparent in a certain kind of decay that commences, as Dr. Duval has very plainly demonstrated, between the enamel and the ivory, when the layer of enamel has been removed by the file or any other means;

3d. Is it not possible that this sensibility exists in the greyish line, intermediate to the ivory and enamel, which Cuvier supposed to be a prolongation of the internal lamella of the follicle, and in which might still be remaining some of the nerves it contained before entering between the two substances of the tooth at the time of its formation?

4th. If the explanation which I have hazarded be founded upon truth, the rapidity with which the phenomena of *agacement* (setting of the teeth on edge) take place, will be comprehended more easily; the acid, which produces this sensation, can readily penetrate the thin coating of the enamel, and have an immediate action upon this membrane.

The whole of the question relative to the presence or absence of vessels and nerves in the osseous portion of the teeth, may be summed up thus: the tooth is composed of two portions, the producing organ, and the part produced; the former, which is the follicle, is essentially nervous and vascular; the latter, the ivory and enamel, are calcareous substances, in which we discover very little organic matter, and which has not been endowed with nerves and blood vessels.

It is, certainly, not impossible that vessels may be developed in certain teeth that adhere to the alveolus, as they make a part of the maxillary bones; but this is an abnormal condition, and only goes to prove the general fact, that organic matter, secreted in a portion of one body, may become identified with it in some manner, and be endowed with a true organization; this fact does not, of course, affect the general conclusion.

ORDER III.

DEVELOPMENT OF THE TEETH.

The formation of the teeth is the most interesting, and, at the same time, the most complicated portion of the natural history of these organs.

That nothing of importance may be omitted in this part of my treatise, I shall, first, consider the development of the teeth in general, and then, in a second chapter, treat of their particular development.

ARTICLE I.

DEVELOPMENT OF THE TEETH IN GENERAL.

A perfect acquaintance with the development of the teeth, supposes a knowledge of the formation of the follicle and bony portion, and the issue of the tooth from the alveolus.

SEC. 1.—*Formation of the Dental Follicle.*

If the parts which represent the alveolar arches of the fœtus of two months, be carefully examined, a great number of dental follicles will be found lodged in the membranous folds of the gum. These follicles are very small, and are lodged in a groove, which is the rudiment of the alveoli; they are covered by the lowest lamina of the tissue of the gum. Their form is globular; superiorly and inferiorly they adhere to the gums and the alveolar groove, and the vessels and nerves which traverse it; laterally, they are contiguous to the adjoining follicles; anteriorly and posteriorly, they correspond to the gums.

After about four months, according to M. Serres, fibrous partitions, which are subsequently ossified, are developed between the follicles, changing their relations to each other.

At the period of birth, the follicles are, already, completely isolated from each other, and form their vessels and nerves; the canal of the latter, at first a simple groove, is now completed.

If the dental follicle of a young embryo is opened, it will be found filled with a yellowish fluid, viscous like the synovial secretion; acid in some, and alkaline in others; having, also, an unctious appearance, in some cases, by which Ungebaur was deceived. This fluid continues to diminish in quantity, from the first moment it becomes perceptible, until the eruption of the tooth, at which time it disappears altogether.

The bottom of the dental follicle of the embryo is occupied by a very large papilla, which varies in form, according to the character of the tooth which it is destined to produce. It is continuous with the gum at the opposite extremity, by means of a prolongation, which constitutes the *iter dentis*, *gubernaculum dentis*.

The gubernaculum dentis is the throat of the dental follicle. In the first stages of its formation, it is contracted upon itself, and, it is believed, presents an opening, which is afterwards dilated for the passage of the tooth; anatomists, however, are not all agreed with regard to the permeability of this part. Fallopius, who appears to me to have been the first to describe it, represented it as a cord. Herissant asserts that this prolongation is perforated, and that the opening through it closed by what he calls the second or temporary gum, but that it opens to the surface of the permanent gum. M. Serres and M. Delabarre contend, that it is really perforated; an opinion in which they are not sustained by M. Rousseau and M. Cruveilhier. M. Rousseau states, that he succeeded in injecting it, as M. Delabarre had done, but attributed the opening made, rather to the means used, than to the existence of any natural perforation. Finally, Herissant asserts, that the gubernaculum dentis is encountered in all the follicles, (a fact which appears now to be generally admitted,) whilst Fallopius and M. Serres attribute it, exclusively, to the teeth of second dentition.

Be this as it may, the structure of the dental follicle of the fœtus should be studied with so much greater care, as a knowledge of this difficult point of anatomy is absolutely necessary to the comprehension of the development of the osseous portion of the tooth. I will state, therefore, all that is positively known with regard to it.

There are two points in the history of this structure, about which, amongst anatomists, there is no difference of opinion: the formation of the papilla, which occupies the bottom of the follicle, by the extremities of the vessels and nerves which reach it, by means of its pedicle; and the constitution of the wall of the follicle, by means of a membrane joined to the gum. All that remains to be determined, consequently, are the disposition and structure of this membrane.

Jourdain, Herissant, Desmoulins, M. Serres and Professor Cruveilhier, supposed the wall of the follicle to be formed of a single membrane, which lines the alveolus down to the pedicle of the papilla, where, according to the first two, it terminates; but which was then, according to the others, reflected upon the papilla, and could be traced up to the summit of that body. Herissant added, that this membrane is gathered in at its middle portion, and adheres closely to the neck of the tooth.

Hunter and Blake supposed the wall of the follicle to be formed by the juxtaposition of two lamellæ, which terminate upon the pedicle of the papilla, without being reflected upon it.

Bichat and Cuvier admitted that the wall of the follicle was composed of two laminæ; but believed that the external one terminated upon the pedicle, whilst the internal, like a serous membrane, was reflected over the whole surface of the papilla.

Delabarre describes, also, a double laminæ, as composing the wall of the follicle; the external comes off, according to this author, from the fibro-cartilaginous tissue which covers the alveoli, and which assists in forming the gum, and descends without presenting any thing remarkable to the pedicle of the papilla, near which it terminates. The internal, on the contrary, is directly continuous with the mucous membrane of the mouth; it goes downwards, directed towards the lateral part of the papilla, and terminates at the point which corresponds to the neck of the tooth. Thus the dental follicle, according to Delabarre, presents two cavities—one which takes in the summit of the papilla, another which corresponds to the pedicle of this part; in the first the crown is afterwards formed, in the second the root of the tooth.

Although at first sight some differences appear between the

preceding accounts of the dental follicle, it will be found, on a closer examination, that, in fact, no real differences exist. It will be readily seen, indeed, that the account which represents the wall of the follicle as simple, is not essentially different from that which recognises two distinct membranes; this apparent discord depends upon the latter describing the alveolar periosteum as belonging to the follicle, and the former carefully distinguishing it.

We are enabled, then, to reduce to three, the opinions of the principal authors, with regard to the organization of the dental follicle: the first in which the membranes, constituting the follicle, are represented as terminating upon the pedicle of the papilla, and being more or less reflected upon it; the second, in which the pulp is represented as being covered by the internal membrane; the third, which is founded upon the insertion of this internal membrane upon the lateral part of the papilla.

This last opinion has in its favor fewer probabilities than the two former, which, as I have shown, very nearly resemble each other. In the first place it is unfavorable to the analogy which exists between the follicles of the hair and the nails, and those of the teeth; and, secondly, what appears to me more conclusive evidence against this opinion, no one, as far as my own knowledge extends, has proved its truth by actual dissections; for myself, I have always sought in vain for this peculiar formation.

Hunter considered the internal membrane of the follicle as essentially vascular; Blake differs with him in opinion, and Fox asserts that the whole thickness of the follicle is abundantly provided with vessels.

Herissant has described upon the external membrane of the follicle a curious and very important arrangement: "If this membrane," says he, "be detached with precaution from the crown, and its interior surface examined, immediately, with a magnifying glass of three or four lines focus, the beholder will be struck with wonder at the appearance of an infinite multitude of very small vesicles, that, by their transparency, resemble those with which the ice plant (*glaciale*) is covered. They are disposed, with much order, in ranges one above the other, which are, for the most part, parallel with the base of the tooth. These vesi-

cles, at first, contain a very clear and limpid fluid, which afterwards becomes thickened, and resembles milk in appearance. Now we cannot be mistaken in determining the purpose for which this fluid is intended, and cannot hesitate to conclude, that, when it is shed upon the crown of the tooth, and acquires all its consistence, that the tooth will be ornamented with the enamel which is so pleasing to the eye."

M. Rousseau, Desmoulins, and Professor Cruveilhier have made observations similar to those of M. Herissant on the vesicular elevations which exist upon the free surface of the internal membrane of the follicle.

Sec. 2.—*Development of the Osseous Portion of the Teeth.*

A short time after the first appearance of the follicle, towards the third month of fœtal life, ossification commences upon those teeth which subsequently first make their appearance through the gum.

It is well known that this formation is accomplished in the interior of the follicle, but authors are not all agreed relatively to the precise point upon which the first portions of calcareous matter are deposited. Cuvier asserts, that it is between the papilla and the part of the internal membrane which covers it; others contend that it is in the cavity of the internal membrane.

Be this as it may, we know that the crown, and particularly the points upon the crown, are first ossified. The deposition of calcareous matter is preceded by a manifest reddening of the pulp. This deposition commences by as many points as the crown of the tooth is to present after its complete formation, in the form of scales, or rather little caps, which cover the elevations of the pulp; thus, on the incisors, ossification commences by three points, according to Hunter and M. Oudet; by one, only, according to Meckel, Blake, and Albinus; upon the canine teeth by one, and upon the molars by as many points as the tooth afterwards presents.

The dimensions of each of these rudimentary parts are, according to M. Rousseau, about a half line in breadth, and a six-

teenth of a line in thickness; they are always in a greater state of development towards the outer than the lingual side. Their respective volume diminishes, also, in proportion as they approach the condyles.

The enamel, according to Auzebi, Jourdain, and M. Rousseau, is secreted before the ivory. Desmoulins entertained the same opinion; and he assures us, that this manner of formation takes place in the cyprinus; the crowns of their teeth, according to his account, being as complicated as the incisors of the rodentia. In the teeth of these animals, he says, the shell of enamel remains for a long time soft and flexible; that it is sometime before it takes its proper consistence, and is moulded upon the elevations and indentations of the papilla.

Most anatomists maintain, on the contrary, that the ivory is secreted first, and that the enamel is formed after the surface of the crown of the tooth is ossified. Cuvier states, that he has seen the two substances appear almost simultaneously.

Many different hypotheses have been advanced relative to the mechanism of the formation of the teeth. Seduced by a false analogy, admitted *a priori*, between the bones and the teeth, anatomists believed, for a long time, that the ivory was formed by an osseous transformation of the pulp. It must be admitted, that the gradual lessening and final obliteration of the dental cavity, in old persons, appears, in some degree, to sustain this theory, which has lately been adopted by M. Léveillé. The most simple direct examination will suffice to show, however, that this is not true; the rudimentary formation is only superimposed upon the pulp, without adhering to it, which would not be the case, even if the most superficial part of the pulp underwent an osseous transformation.

Bunon, in 1743, Hunter, and Cuvier, strongly opposed this doctrine. They have shown that the ivory is secreted by the pulp in the same manner as the nail by the matrix, and the epidermis by the skin. Bunon compared this formation to the shell of certain crustacæ.

The history of the enamel is much more complicated than that of the ivory; and it must be admitted, that upon the well attested facts, in our possession, the theory of its formation is

much more difficult to establish. The secretion of the enamel differs in every way from that of the ivory, and as such a short period elapses from the commencement of its formation to its completion, it is much more difficult to observe it in all the stages.

Bertin, Hunter, and many others, have asserted that the enamel is secreted by the internal membrane of the follicle, and perhaps, also, by the pulp, from the first moment of the appearance of the germ; that it remains in solution in the fluid of the follicle up to the time of the formation of the crown, when it is deposited in crystals upon its external surface. Hunter compared this deposition of the enamel upon the crown of the tooth to the crystalization of the salts of the urine around a foreign body in the cavity of the bladder. One fact appears to give some support to this theory; the fluid of the follicle, abundant at first, diminishes in proportion to the development of the tooth, and disappears entirely; "taken up, doubtless, by the absorbents," they say, when the enamel is completed. Hunter averred, that these phenomena take place in the horse, the ass, and the sheep, and thought there was no reason why they should not also occur in man. Cuvier and M. Serres are opposed to this doctrine of Hunter. The fluid of the follicle, according to these authors, takes no part in the formation of the tooth; is poured out of the opening of the follicle at the moment of its eruption, and disappears entirely when this is effected.

It is generally admitted, at present, with Herissant, Meckel, Cuvier, &c., that the enamel is very soft at the time of its formation, and that it is deposited directly upon the tooth by a secretion of the internal membrane of the follicle, for which purpose, the little vesicles, said to exist in this membrane, by Herissant, appear to be destined.

According to Cuvier, the enamel is not deposited immediately upon the crown of the tooth, but upon that portion of the internal membrane which covers the crown. In this manner, as I have before remarked, the lamina is pressed between the two substances, and remains a greyish line during life, a proof of this arrangement.

As regards the opinion of M. Delabarre, who believed the enamel to be formed by the papilla, and, transuding through

the external laminæ of the ivory, was deposited upon the surface of the crown, it appears to me, notwithstanding the authority of the author, to be altogether inadmissible.

One consideration seems, at first sight, to embarrass this point of the natural history of the teeth: why is it that the enamel is deposited upon the crowns only, and never upon the roots of the teeth? This question is of importance, and merits attention.

In the first place, it is evident that this difficulty will not affect the theory of Cuvier, according to which the ivory is not formed in the same cavity of the follicle in which the enamel is secreted, and which contains the crown of the tooth only. The supporters of the almost abandoned theory of the crystalization of the enamel, asserted that the fluid of the follicle disappeared when the crown was fully formed, consequently there could be no vitreous deposition upon the root.

Herissant, and those who observed the little glands destined, according to this anatomist, to the secretion of the enamel, supposed that these little organs disappeared after the completion of the crown of the tooth, and that thus the root, which is afterwards formed, has no deposition of enamel.

Sec. 3.—*Growth of the Teeth.*

The deposition of bone, once commenced, by the papilla, continues as long as this organ receives the materials necessary for its formation. New laminæ, similar to the first, are formed, always interiorly and upon the surface of the papilla. These laminæ are greater in extent in proportion as the development of the tooth advances, up to a certain period, when an inverse disposition will be observed. As the inner laminæ are formed, the external layers become more and more distant from the papilla, which is soon embraced by the bony deposition, on all sides, down to its base. The crown of the tooth entirely formed, the enamel is deposited, and the work of evolution commences; previously to which, however, the tooth, in some persons, remains for a time stationary, at this stage of the formation. The papilla is raised from the bottom of the alveolus; the new portions of ivory, now secreted by it, take the form of rings, less

and less wide inferiorly, which, surrounding the pedicle of the pulp, descend to its extremity, and form the root of the tooth.

At the period to which we have come, the tooth ceases to grow in length ; the new laminæ, which are now formed, can only serve to augment the thickness of the osseous substance, and, as it is always by an internal juxtaposition that this increase takes place, the dental cavity must, necessarily, become more and more narrowed. The pulp is then compressed, and the circulation being obstructed in its vessels, the secretion lessens in quantity, and, at length, ceases altogether.

We have here described the manner in which a tooth, with only one root, the canine, for instance, is formed; this was chosen, as being more simple and easily understood. We will now take up the consideration of one of the multicuspides with a compound root.

The ossification of the tooth commences, as I have stated, by many separate points ; corresponding to elevations upon the papilla ; the little caps, first formed, representing the tubercles which the fully developed tooth will present. These little caps are, from the beginning, convergent towards each other at their bases ; and, by the deposition of new laminæ interiorly, which are always greater in extent than the first, they are, at last, entirely united. There is now formed, upon the superior surface of the pulp, a large inner cap, and the ossification proceeds as if it had commenced by a single point. When the newly formed osseous portion of the tooth reaches the union of the pulp with its pedicles, the calcareous matter is secreted at once around both portions. Each of the pedicles is, separately, surrounded by a tubular deposition of bone, continuous with the circumference of the rest of the pulp. The growth then continues to the end, in a manner precisely similar to that of a simple tooth, with this difference, that, instead of a single hollow cone, a number, corresponding to the roots of the tooth, are formed.

Thus the teeth are formed, from the extremity of the crown to that of the root, and from the exterior to the interior ; they acquire, at once, length and thickness, and are moulded, as it were, upon the papilla, which they enclose more and more narrowly.

The growth of the osseous portion of the tooth is, necessarily, confined within very narrow limits, and the exact conformation of the future tooth, as it always takes the form of this rudimentary part, may be easily ascertained from the size and length of the papilla. In proportion as the tooth advances in its formation, as we have seen, the pulp is more and more closely embraced by the osseous laminæ, until its functions, at first obstructed, cease entirely; at this moment its growth is completed. As the tooth is developed, the secretion of osseous matter becomes more and more difficult, for the very deposition of this substance cuts off a supply, which at first seemed inexhaustible; the pulp, thus containing, within itself, the elements of its own destruction.

From this description, it will be at once perceived, that the definite growth of the teeth is attributable to the form given to the calcareous deposition by the papilla; yet this consequence, which so naturally flows from the facts in our possession, was not, until very lately, properly appreciated. We are indebted to M. Oudet for the precise knowledge we now have of the subject; he satisfactorily explained it, in his paper upon the dentition of the rodentia. M. Oudet established, in this remarkable production, that it is owing to the pediculated form of the dental papilla in man, that the growth of the tooth is limited. He then showed that, in the incisors of the rodentia, which increase indefinitely, the dental papilla is of a form directly the reverse of that of the human tooth. This papilla has, indeed, no pedicle; it is conical, and is attached to the bottom of the follicle and alveolus by the base of the cone which it represents. In consequence of this formation, the papilla of the incisors of these animals continues to secrete the calcareous matter, without being exposed to the danger of obstruction on the side from which it receives its vessels and nerves. Thus, never being in the least degree compressed, nor interrupted in its functions, it continues to deposite new matter, and the tooth is pushed towards the exterior, till the end of life, unless, from some external cause, it is materially injured or destroyed.

This indefinite growth of some of the teeth of certain animals must give to them, in time, a considerable length, as is observed in the tusks of the elephant. In the rodentia, also, when the

incisors are not worn away at their free extremity, in proportion to the deposition which takes place at their base, they sometimes acquire enormous dimensions, and are the cause of serious accidents.

M. Devergie, in 1825, presented to the Academy of Medicine, the head of an old rat, killed at the Ecole-Militaire, which furnished a fine example of this kind. The right superior incisor, on issuing from its alveolus, curved immediately downwards and backwards, into the interior of the mouth; penetrated the left nasal fossa, entering at its posterior opening, traversed this cavity from behind forwards, and issued again from the left alveolus next to its own, by the side of the left incisor, which it did not displace; it then recurves downwards and backwards, and terminated under the left orbit. This tooth described a double spiral, of which the two circles, successively decreasing in diameter, were directed from before backwards, and from right to left.

The left superior incisor, the alveolus of which was traversed by the tooth I have just described, was equally curved, but the circle it formed did not take the same direction as that of its fellow.

The incisor teeth of the inferior jaw formed two long tusks, curved upwards and outwards, of which the right, thrown more backwards, described a circle of about eight lines in diameter. In passing before the orbit, it destroyed the lower border, (the eye of this side was atrophied,) in which it had hollowed a groove; its point recurved upon the cranium, which, had the animal lived, would, in a short time, have been inevitably penetrated. The molar teeth of the right side had partially changed their direction, and were inclined inwards, so as to come into contact with those of the superior jaw.

True *phanères*, according to the expression of M. de Blainville, the teeth are developed and increase in size like them. Their growth is not indefinite, like the hair and the nails, as their papilla is neither conical nor sessile; it is, on the contrary, limited, like that of the feathers of birds, in consequence of the formation of their papillæ, which are alike elongated and supported by a narrow pedicle.

A careless observer may be deceived by the apparent lengthen-

ing of the teeth of old persons, in consequence of a contraction of the alveoli; but a close examination of the enamel will show that, instead of being increased in length, they are actually worn away by the friction to which their extremities have been exposed. It is, undoubtedly, this mistake which has led many anatomists, and particularly Fallopius, to attribute to the teeth an unlimited growth.

The formation of the calcareous portion of the teeth differs altogether from that of the other parts of our body; it takes place by simple juxtaposition, like inorganic formations, and not by intro-susception. Hunter's fine experiments have established this fact in the most positive manner; since, as we have seen, when a young animal is fed upon madder, those parts of the teeth only which are forming at the time it is submitted to the experiment, become reddened.

Many disorders of dentition go, equally, to prove this theory. It is well known, that it may be ascertained by an experienced observer, even in conversing with persons who show their teeth when speaking, whether they have been, at the period of the formation of these organs, affected with any serious disease. We observe, upon the crowns of the teeth, elevated undulating lines, irregular rough grooves, or little depressed points, which constitute what is called *erosion*, but which Duval preferred to designate *atrophy* of the teeth. These organs, in the adult, present a faithful image of the condition of the whole organization at the time they were being formed. If a serious malady committed its ravages at the commencement of dentition, when the follicle first began to secrete the crown, then the superior portion, only, of this part of the tooth will appear changed, the rest being in a normal condition. The close observer is enabled, as was remarked by the illustrious Chaussier, to indicate, when the alteration of the parts is disposed in bands, with intervening sound portions, the periods of health and disease, which have, in the infancy of such persons, succeeded each other.

Sec. 4.—*Eruption of the Teeth in General.*

When the teeth have attained a certain degree of development, the sac in which they were first formed is incapable of holding them any longer; they are consequently carried outwardly, and the crowns soon make their appearance, devoid of covering, in the mouth.

Generally, the eruption of the teeth does not commence till after the period of birth; the time, however, at which they make their appearance through the gum, varies in different individuals, but particularly, as will be presently shown, in regard to the species of teeth. Dentition may also be advanced or retarded by disease, as was remarked by Alphonse Leroy. "I have often seen," said he, "an infant cut two teeth before the ordinary period, when the nurse had had an attack of fever or inflammatory congestion; her milk, surcharged with caloric, accelerated dentition, in the same manner that plants are made to grow rapidly, and to bloom early, by exposing them to the influence of artificial heat, and watering them frequently and copiously: but, as the frail flowers, thus hurried forward before their time, fall without producing fruit, so do the precocious teeth of children waste away and fall soon after their eruption."

The order in which the teeth make their appearance through the gums, is more exactly determined than the period at which their formation commences. The teeth of the inferior generally make their appearance before those of the superior jaw; not the whole range, however; they are cut in pairs, and each pair which appears in the lower is succeeded by that corresponding in the upper jaw.

Generally, the eruption of the teeth progresses regularly, from the anterior to the posterior part of the jaw; the canine, which do not make their appearance until after the first molaris, is an exception to this rule. Anatomists are not all, however, as will be seen from the following extracts, agreed upon this point.

The celebrated Sabatier, in his treatise upon anatomy, says, "Some time after birth, the teeth make their appearance, successively, in each jaw; their eruption taking place sooner in some

and later in others. The first rarely make their appearance earlier than the seventh or eighth month, or later than the twelfth or fourteenth. The inferior middle incisors cut the gum first, and frequently at an interval of from five days to three weeks; they are followed by the superior central incisors; then succeed the lower lateral incisors, followed by those above; *the inferior canine teeth next make their appearance, and are followed by those in the upper jaw;* and, lastly, the two molars on each side of both jaws appear.

M. Boyer, in his account, differs but little with M. Sabatier: "The two middle incisors of the lower jaw," says he, "first pierce the gums; sometimes they appear together, but more frequently at an interval of three weeks or a month. The eruption of the two middle incisors of the inferior is followed by that of corresponding teeth of the superior jaw; then the lateral incisors of the inferior jaw appear, and are soon after followed by the superior lateral incisors; *to the latter succeed the lower, and then the upper canine teeth.* The molars rarely appear before the age of nineteen months or two years; the two first inferior molars first show themselves, and are followed by the corresponding superior molar teeth: to these succeed the second lower molars, which are sometimes accompanied by those of the upper jaw."

According to Sabatier and Boyer, the eruption of the canine teeth takes place immediately after the lateral incisors, and before the molars. Bichat adopts the same order in his general anatomy: "We soon see appear," says he, "sometimes singly, sometimes simultaneously, the two middle incisors of the inferior jaw; soon after, the corresponding incisors of the superior jaw are seen; a month or two after, the four other incisors pierce the gum; *at the end of the first year, usually, the eruption of the canine teeth takes place;* about the end of the second year, or, as is often the case, somewhat later, two molars in each jaw are seen to issue, and these are soon followed by the two others."

A great number of reasons have been assigned to account for the eruption of the teeth, which, as in many other instances, are mostly wide of the truth; who would believe, for instance, that this phenomenon has been attributed to the gravitation of the teeth; to the pulsations of the dental arteries, or to a contest

which takes place between the tooth and the gum, in which the latter are always victorious! Such theories as these do not, of course, merit a serious refutation. The opinions of Herissant, of Serres, and Delabarre, must not, however, be treated so lightly. According to Herissant and Delabarre, the tooth is drawn outwardly by the contraction of the internal lamina of the membrane of the follicle, which, as we have seen, is attached to its neck; the neck of the tooth is, by this means, drawn towards the surface of the gum, and, when it reaches that point, it does not go farther, because the contractile power of the membrane is then exhausted. This theory is very simple, besides being very ingenious, but, unfortunately, it is very difficult to sustain. How can it be supposed, indeed, that the almost arachnoidean membrane, which lines the internal face of the follicle, possesses the power to draw out such a body as the osseous portion of the tooth? But it is useless to perplex ourselves to explain a phenomenon which is so easily understood. The cause of the eruption of the teeth is very simple and very apparent; they issue from their alveoli because they have attained to such a size that they can be no longer contained in them; in a manner precisely analogous to that in which the hair and nails pass from their particular matrices. It is a great mistake to suppose that the contraction of the alveoli, and the elevation of their basis, assist in the eruption of the teeth; for, in the first place, the alveoli become narrowed very little, transversely; and secondly, they become deeper and deeper, in proportion to the development of the teeth. The alveoli, indeed, are double the height of the body of the bone, as in the inferior jaw.

Be this as it may, the following phenomena characterise the eruption of the teeth; the tissue of the gum is elevated, the mucous membrane is swollen, reddens, becomes inflamed and painful. Soon after, the red color disappears, and they become white; one or more openings are seen upon the surface, according to the number of points the rising tooth presents, and the tooth comes forth. If it be simple, it comes outwardly by dilating the only way prepared for it, but if the crown is broad, several openings are cut through the gum, which soon, however, unite into one.

A difficulty naturally presents itself here: is the opening which the tooth makes for itself merely a dilatation of the throat of the follicle, or is it the result of destruction of the gum at the point where it passes? M. Delabarre, without hesitation, adopts the first theory? "The fibro-mucous canal of the *iter-dentis*," says he, "is neither cut nor torn by the points which the tooth presents; the way is traced out, and all that remains to be done is to dilate it." Without disputing, positively, this position, it is evident that a distinction is necessary. It may, possibly, be admitted that the canine teeth, and even the incisors, merely dilate the throat of the follicle, without cutting or tearing the gum; but the same explanation will not apply to the molars, as the gum, when these teeth rise, presents several openings which cannot certainly be attributed to the *iter-dentis*. This view is, however, eminently philosophical; it includes all that occurs in the normal condition of the eruption of the teeth; the several openings apparent in the gum in the case of the molars may constitute but an exception, an anomaly. New observations appear to be required to establish this point.

M. Delabarre, besides, was not the first who supposed that the teeth issued from the alveolus by the natural opening of the follicle. Herissant has expressed himself very clearly with regard to this subject. After having established an important distinction between the gum, properly called, which he designates, as has been already seen, the permanent, and the cartilage that covers it, which he calls the temporary gum, he adds: "The true or permanent gum is neither pierced nor torn by the teeth, as appears up to this time to have been believed. In order to have an adequate idea of the manner in which the teeth pass from the alveoli into the mouth, the fact must be recalled, that they are, each, enclosed in a little sac or thin membranous follicle, the orifice of which looks toward the opening of the alveolus. Those sacs are prolongations of the temporary gum, and ought to be well understood; as each one resembles a little closed purse, we will give them that name. This purse is closely adherent, interiorly, to all the surface of the crown of the tooth which it contains; but their adherence is more intimate at the place where the enamelled portion of the tooth is distinguished

from the root, and the latter is shut up in the lower part of the purse, which adheres to it but very slightly.

"Let us now take up the consideration of a tooth which has acquired its consistence and growth in this purse; the opening is then insensibly dilated; its lower portion is carried little by little toward the alveolar opening, till the neck of the tooth is brought to a level with the edge of the socket, upon which the purse is turned from within outward to form the permanent gum. It is by this sort of reversing of the purse that the forming tooth is carried out of the alveolus, where, finding in its way the temporary gum, it at last, after repeated efforts, tears through it."

Before the teeth cut the gums, they frequently give rise to disorders which jeopardize the life of the child; these are caused by the pressure exercised upon the adjoining parts, and the irritation which results from it. Some of the disorders, attendant upon dentition, have been attributed, but without good reason I think, to pressure made upon the nervous trunks by the roots of the teeth. At this period, indeed, they are shut up in perfectly formed canals, and are placed beyond the reach of irritation from this cause. With regard to the filaments which come off from these trunks to form the pedicles of the papilla, this, however, is not the case, as I will presently show.

ARTICLE II.

DEVELOPMENT OF THE TEETH IN PARTICULAR.

The history of the particular development of the teeth is naturally divided into three parts: the consideration of the temporary, permanent, and a third set of anomalous teeth, with which nature has sometimes endowed old persons, and which, for this reason, has been termed a senile dentition.

Sec. 1.—*Development of the Temporary Teeth.*

FIRST DENTITION.

The first twenty teeth of the child, including the eight incisors, the four canine, and the eight molar teeth, are destined to have but a very short existence. They do not ordinarily remain beyond the first years of life—for which reason they have been called *temporary*, *deciduous*, *infant*, and *milk teeth;* and all the details which relate to their history are recorded under the name of first dentition.

What has been already said with regard to the period at which the dental follicles first make their appearance, relates to the temporary teeth; and a repetition of these details is, of course, unnecessary; neither will I anticipate any thing in this place that relates to the origin of the secondary teeth, of which I shall treat in the following section.

The germs of the teeth make their appearance in exactly the same order in which they afterwards pass through the gums. M. Serres detected the germs of the incisors and molars at the second month after conception; those of the canine teeth about two weeks later. Their disposition, under the gum, offers nothing which I have not already noticed; it is only necessary to add, here, that the point above them is harder, now, than it is at a later period, and that it is covered by a cartilaginous production, which is called the dental cartilage, and which has been, very justly, compared, with regard to its consistence, to the beak of birds. This cartilage, according to M. Oudet, may be separated from the gum by maceration; it forms a sort of crust, which is, frequently, marked with elevations and indentations; its borders cause a slight swelling of the mucous membrane of the gum. This is the cartilage which was considered by Herissant as the temporary gum: "Raise it up," said he, "and you will find under it the permanent gum, in which will be perceived the openings of the dental follicles."

The ossification, or, to speak more exactly, the calcareous secretion commences very early, towards the second month of uterine life. Every fifteen days from this time up to the seventh

month of gestation, according to M. Rousseau, some portion of a new tooth is formed; the whole of the twenty crowns of the temporary teeth may be observed in some stage of development at about this period.

The calcareous deposite of the papilla appears, with regard to time, in the exact order that the follicles are formed, and the eruption of the teeth takes place. It commences first upon the inferior central incisors, then the superior, and successively, upon the lateral incisors, the first molaris, the canine, and the second molaris.

In the fœtus of eight months, each superior central incisor is, ordinarily, about two lines in breadth and two lines in height.

The small lateral incisors, which at this time still preserve a triangular form, are each, according to M. Rousseau, about a line and three quarters in breadth and about a line and two-thirds in height. The canine tooth presents a conical cap about a line in breadth and a line in height.

The first molaris is three lines in breadth at its base, and two lines and a half in thickness antero-posteriorly. This tooth is now divided into two parts, an anterior and a posterior, which, however, are united by a transparent lamella, upon which a little opaque point may be observed. At this stage, each of the parts of the tooth is about a line and a half in breadth at its base and a line in height.

At nine months, the sac of the first large molaris, which belongs to the second dentition, is plainly distinguishable; a very small point of ossification only can be perceived at this period.

The second molaris which completes the temporary set of teeth, is now formed of four little enamelled caps, disposed in a circle, but not yet united. The first of these caps presents itself at the anterior part; it is a line and three quarters in the greatest diameter of the opening at its base; a line, only, in its antero-posterior diameter, and a line in height. The second cap, situated on the posterior or lingual side, differs, but little, from the first in its dimensions. The third, smaller than the two preceding, is more conoidal, and but a line in diameter at its base. The fourth and last of these caps is the smallest of all, and is placed upon a circular base a quarter of a line in diameter.

The temporary teeth soon begin to issue from their alveoli. Pliny, Columbus, Van Swieten, Donatus, &c., relate examples of the premature eruption of the first teeth. Haller mentions nineteen children who cut their teeth before the usual time, and Polydorus Virgilius relates the case of an infant who had six teeth at its birth. Charles Rayger, on the other hand, makes mention of a woman whose canine teeth did not make their appearance until her thirtieth year. Usually, however, the first teeth appear from the fourth to the eighth month after birth. The cases cited by Fauchard and Bourdet, of some individuals, who never had any teeth, or those who did not cut the full number, are altogether exceptions.

About the eighth month, the two central incisors make their appearance; from the tenth to the twelfth, the two laterals; from the twelfth to the fourteenth the four first molars; the canine teeth at eighteen months, and the four second molars at about two years.

The temporary teeth present very marked differences from those which succeed them. They are but twenty in number, and the supposition that there are twenty-four is altogether a mistake. The four teeth which appear about the fourth year are never shed; they do not, consequently, belong to the temporary set, but are the first permanent large molars. The necks of the temporary teeth are surmounted without by a slight elevation, which gives to them a particular rounded appearance; their crowns are whiter and fuller than those of the permanent set. The incisor and canine teeth are smaller, whilst the molars, on the contrary, are larger than those of the second dentition. The incisor and canine teeth of this set differ but little in form from those which succeed them, but it is not so with the molars; the latter, which have the form of the permanent great molars, are replaced by the bicuspides of the second set.

The reason of this remarkable difference may be inferred from the use which the great molars subserve in the economy. These teeth are much more important for the purpose of grinding the food than the small molars, which may, almost, be considered as of little service in mastication; and, as the jaws of the child are

too small to give room to all the molars found in the adult, the most useful are chosen.

The first molaris of the superior jaw is quadricuspidated; its root has three divisions, two of which are joined together, the other isolated. The second molaris, which is larger than the preceding, has five points and is sustained by three divergent roots. The two inferior molars resemble very nearly those of the superior jaw, except that they are not quite so large.

The roots of the temporary are generally shorter and more slender than those of the permanent teeth. That they are entirely deprived of roots, according to Van Swieten and Auzebi, is an opinion it is hardly necessary to disprove. This error took rise from the fact that the root of this set of teeth is most commonly destroyed at the time of their spontaneous fall. Auzebi, however, believed so firmly that this was the fact, that he criticised, very pleasantly, those who thought it necessary to discuss the question, whether the roots of the temporary teeth were destroyed or not by the pressure of the rising teeth of the second set.

The substance of the deciduous teeth is very analogous to that of the second set; it is not, however, so hard. They crack with a particular facility, when exposed to desiccation; a fact which I have not seen mentioned by any author.

These teeth are rapidly destroyed by friction. M. Murat has related the case of a young physician, whose first teeth, never having been shed, were worn down almost to the roots, like those of an old person. M. Deneux, and some others, have observed similar cases.

The temporary teeth receive their arteries from a special branch of the dental trunk which occupies a distinct conduit in the dental canal itself. This conduit has been known for a long time; Jourdain has described it in the two following passages:

"The disposition of these *becs* produce a groove and a foramen. By the superior groove passes the foramen of the principal dental trunk; and by the inferior foramen various ramifications of this trunk enter, to be distributed in the substance of the base of the jaw, to furnish the fluids and branches necessary to the formation of the germs of the permanent teeth, and to close their sacs or matrices."

"The fluids which the permanent teeth receive, are carried by this branch, which, as I have stated, passes by the inferior foramen, and which I have observed in a jaw of seven or eight months' formation. At this time, this branch alone occupies the maxillary canal, as that which had supplied the temporary teeth has been confounded with it."

This description of Jourdain had been entirely forgotten, when M. Serres, in his researches upon the teeth, discovered the conduit in question, of which he has given a more exact description than Jourdain; he showed, also, that it was represented by an analogous canal in the superior maxillary bone.

This canal commences behind the superior opening of the inferior maxillary conduit, under which it goes a little towards the outside and terminates under the alveoli of the milk teeth, after having been partly confounded with the diploë of the bone, and opening in a special hole situated under the mental foramen. It is very large in the fœtus, and still remains quite large in the infant; but it becomes more and more narrow as it is affected by the pressure of the secondary teeth. Finally, it disappears, except in some cases after second dentition is effected.

The temporary teeth do not remain longer than from the sixth to the twelfth or thirteenth year. Towards this period of life they become, successively, loose and fall, very nearly in the order of their formation and eruption.

But a certain combination of circumstances is necessary to the shedding of the temporary teeth, which does not always exist, and the absence of which, either retards or prevents altogether this phenomenon from having place; authors relate many instances illustrative of this fact.

At the moment of their falling, the teeth have undergone a certain number of modifications which should be understood; their root is, to a greater or less extent, destroyed; this is almost invariably the case with the molars, but less constantly with the incisors and canine teeth. This alteration is not confined to the extremity of the root, for these parts become thinner, more irregular in their whole length, their canal is enlarged, and, according to M. Duval, the internal portion of the crown itself is eroded.

Phenomena as curious as these, and of as constant occurrence, could not fail to attract the attention of physiologists, and explanations of the subject have crowded upon us from all sides.

Some authors, Delécluse, Ungebaur, and Serres, have attributed the destruction of the roots to the compression exercised upon the dental artery and its obliteration; some to the mechanical action of the secondary teeth; Hunter to a peculiar action, and Delabarre to the production of a special absorbent organ.

In whatever manner we examine this question, we are compelled to recognise the fact, that absorption, as Hunter has well expressed it, plays the principal part; but the question arises, why does this absorption take place? Under what influence does it commence and terminate at a certain period? Here lies the difficulty. The fall of the teeth is, undoubtedly, determined by some other cause, than the influence of pressure, for Hunter, and other anatomists, have observed it to take place under circumstances which precluded the possibility of pressure.

"*Vidi duas tresve maxillas, in quibus secundi molares lactei deciderint communi methodo, absque ullo supposito dente, et in una maxilla ubi ambo molares deciderint, eamdem inveni circumstantiam.*"

The temporary teeth sometimes remain after the eruption of the corresponding teeth of the second set; but this circumstance must be attributed to some other cause than a defect of pressure.

The milk tooth, at the time it is shed, appears to have undergone a change, as if it had been, for some time, reduced to the condition of a foreign body; it is eroded in the same manner as pessaries, which have remained too long in the vagina. Is it not very probable, consequently, as was thought by Delécluse and Ungebaur, and was latterly maintained by M. Serres, that the vessels which go to the pulps of the temporary teeth are destroyed by the pressure of the secondary teeth? Indeed, this fact appears to me well established. If the jaw of a child, at the age when the alveoli of both dentitions and the canals, for the passage of the dental vessels of both sets of teeth, exist, be examined, we will be struck with the complicated course the vessels which supply the deciduous teeth are compelled to take, after leaving the main trunk, in the dental canal to reach their

alveoli. The canal in which the trunk of the vessel of the deciduous teeth passes, occupies the lowest portion of the maxillary bone, under the alveoli of the teeth of the second dentition, and the branches sent off are compelled to pass over the sides of the alveoli of the permanent teeth, to reach their destination. This being the case, it is physically impossible that these vessels can escape obliteration under the pressure, daily becoming greater, which the growing secondary teeth and alveoli exercise upon the adjoining parts.

Sec. 2.—*Development of the Permanent Teeth.*

SECOND DENTITION.

When we reflect upon the difficulty with which we have obtained the teeth intended for ordinary usage, and which should, unless destroyed by disease, serve us to the end of life, it seems as if nature, in this instance, had rambled a little from her usual simple and provident course. Would it not have been better, we are at first inclined to ask, to have at once provided us with permanent teeth, without undergoing the labor of supplying two sets? But we may well answer, without fear of being exposed to the accusation of optimism, that nature here, as always, has done that which was necessary and no more.

The child, indeed, requires teeth in his earlier years, but his jaws are too slender and too weak to support teeth of such size as those of the permanent set. The very limited extent, anteroposteriorly, of the maxillary arches, rendering them incapable of receiving all the molars, it was necessary, first, to place in them those which would render the greatest service, the large molars. As the jaws would have been obstructed, however, in their action, after the child became older, by the presence of so many large teeth, it became necessary to furnish those which were more in relation to the changes which take place: consequently the large molars were replaced with the bicuspides.

The permanent teeth, as has been shown, are thirty-two in number. They are, naturally, divided into two series; the first,

the true teeth of replacement, comprises the twenty anterior, which succeed the temporary teeth; the second, the twelve teeth which are primitively permanent, and which represent the large molars of the adult.

We are acquainted with the characteristics of the permanent teeth, as they are those found in the adult subject, and have served as a type for the general description given at the commencement of this treatise. All that is necessary here, is to bring them into comparison with the temporary teeth. The six central permanent teeth occupy a greater space in the jaw than the four small molars; this is the reverse of the first dentition, the incisor and canine teeth of this set not forming so large an extent as the molars. The two first permanent molars are bicuspides, but they succeed large molars. "This, indeed," says Cuvier, "is a general rule; the first molars of replacement have, always, a crown less complicated than those which preceded them; this complicated crown is, however, observed in those teeth posterior to those which represent the first set.

The permanent teeth receive their vessels from the trunk of the dental artery, which passes immediately under their alveoli.

We begin to perceive the germs of the permanent teeth at about the third month of uterine life, almost as soon as those of the temporary teeth are distinguishable. At this period they are very small, are suspended from the gum by a mucous cord about a line in length, and are placed behind the germs of the temporary teeth. The germs first perceived are those belonging to the series which replaces the deciduous teeth. The order in which they are formed, and become apparent to the eye of the anatomist, is the same as that attributed to the temporary teeth. M. Serres has placed the appearance of the germ of the first great molaris in the last period of fœtal life; those of the two last are never seen till after birth.

In the fœtus, the germs of the permanent teeth are much smaller than the others. When first distinguishable, they are both placed upon the same plane, but the maxillary bone, soon acquiring greater height, the former are carried downwards, passing by the germs of the first teeth, and placing themselves beneath, in consequence of a remarkable elongation of the throat, *ductus dentis.*

At first, the germs of the two dentitions are placed together, in the same alveolar furrow, but afterwards partition walls separate them, and constitute distinct alveoli.

After birth, in the inferior jaw, the central incisors are placed against the posterior face of the roots of those they are destined to replace; and, as they are larger, they overlap a little their alveolar walls. The permanent lateral incisors, larger still than the preceding, are placed behind the partition which separates the lateral incisors and the canine teeth of the first set; the canine is more deeply buried in the thickness of the jaw than the others; it is placed out of the alveolar range, and under the anterior lamina of the alveolar process, which it sometimes raises in a remarkable manner. The first small molaris is placed under and behind the tooth it is to follow, whilst the second small molaris is exactly subjacent to the second temporary molaris.

The reason why the canine is thrown out of the range of the arch formed by the other teeth, as we have stated above, is very obvious: the molars of replacement correspond exactly to those of the first dentition; the incisors of the second set occupy as great a space as the temporary incisors and canine teeth together, thus the rudimentary permanent canine teeth are compelled to seek a position out of the circle.

About a year after birth, the germs of the teeth of the second dentition are separated from each other and from the milk teeth, by bony walls, which form for them special cavities. The cavities or alveoli are pierced with a canal at each of their extremities, to give passage, below, to the vessels and nerves which form the pedicle of the dental pulp, and above, to the throat of the follicle, or *ductus dentis*. The canals situated at the upper surface of the alveoli were, at first, observed in the anterior part of the jaw only, and for that reason were called incisors; but they are much more general than was then supposed. They do not open into the alveoli of the temporary teeth, as was believed by Fallopius, but terminate upon the alveolar arch, behind the alveoli of these teeth.

The follicle of the permanent tooth is a dependence of the mucous membrane of the mouth, like that of the temporary tooth.

It is continuous with that membrane, by means of a long *ductus*, which has been well described by Fallopius, who called it a second pedicle of the papilla. This *ductus* passes through the bony canal in the superior part of the alveolus, and reaches the mucous membrane. Albinus erroneously believed that the *ductus* of the molaris terminated in the alveolus of the deciduous tooth.

Meckel believed that the follicles of the temporary and permanent teeth were connected by their fibrous membranes. He supposed, also, that those of the permanent proceeded from those of the temporary teeth; "at first," says he, "they rest immediately upon them, but afterwards they are only joined by long and slender cords." In my observations, however, I have discovered that this communication exists between the external laminæ of the dental follicles only, and that the internal, so essential, are entirely isolated from each other. If this communication ever exists, it must be at a very early period, for I have never been able to discover it, although I have examined the follicles of the permanent teeth, from the first moment they became perceptible.

The permanent teeth of replacement are developed in their follicles, in the same order, and subject to the same laws which govern all the teeth in their increase, which I have mentioned in the general description I gave, and to which it is useless to return. When these teeth have undergone a certain degree of development, they exercise a force upon all parts of the walls of their cavities; behind they press upon the lingual lamina of the alveoli; forward they compress the vessels that come from the accessory dental canal to supply the temporary teeth, and first obstructing their canal, at last destroy them altogether; forward and above, they press upon the partitions which separate their alveoli from those of the first set; and, finally, below or above, according to their position in the jaws, they press upon the trunks of the dental vessels and nerves.

At the end of a short time, as I have already explained, when treating of the deciduous teeth, the pedicles of the papillæ of these last are destroyed, their follicles are obliterated, and the teeth themselves, reduced to the condition of foreign bodies,

undergo all the changes which affect unorganized substances in the middle of organized tissues. They become softened, are destroyed at the base, and fall more or less promptly, according to the rapidity with which these phenomena succeed each other.

In this successive elevation of the tooth of replacement, by the sacrifice of the one which precedes it, the septum which separates the two alveolar cavities is destroyed, and they are confounded together, the crown of the second tooth pressing immediately upon the root of the one which precedes it. Sometimes, however, the secondary tooth makes a passage through the alveolar border, without affecting the wall of the alveolus of the temporary tooth. In the first case, the pressure of the permanent tooth adds a new element of destruction to those which already surround the temporary tooth; its fall becomes more certain, and the period less distant when it will be shed; the permanent tooth, then placed in the widened alveolus, finds its way outward without any difficulty. In the other, which Hunter has erroneously represented as the normal condition, the permanent are carried behind the alveoli of the milk teeth, directed in this course by the *ductus;* they make a special opening, by dilating the bony canal described above, and the alveoli of the temporary teeth are pressed upon and destroyed.

It is, perhaps, useless to remark, that the phenomena here described relate only to the twenty anterior permanent teeth, as there are but twenty of the temporary set.

The permanent, like the milk teeth, issue from their alveoli in the following order: the first large molaris, the central incisor, the lateral incisor, the first small molaris, the canine, the second small molaris, the second and third large molars. The first tooth of the second series commences the great change; the whole of the first series then replaces the temporary teeth, and finally, the second and third large molars complete the second dentition.

The first large molaris makes its appearance about the fourth or fifth year, immediately behind the second temporary molaris. Its eruption follows so nearly that of the last deciduous molaris, that some persons have erroneously classed it among the temporary teeth.

The central incisor shows itself from the sixth to the eighth year; the lateral incisor soon follows.

The first small molaris appears about the ninth year; the canine from the tenth to the eleventh; the second small molaris from the eleventh to the thirteenth; the second large molaris from the twelfth to the fourteenth; and, finally, the last great molaris, the *dens sapientiæ*, at a period which varies from the eighteenth to the thirtieth year.

Blake and Bichat maintained that the first temporary molaris was replaced by the two small permanent molars; that this is an error, the most simple inspection of the teeth will prove; an error which I have corrected in my edition of "Bichat's General Anatomy," and which had already been rejected by every anatomist.

All the great molars, when they first make their appearance, are directed obliquely forward, but afterwards take their straight position, when the alveolar arch is more crowded with them.

My subject does not embrace the disorders caused by the eruption of the teeth, particularly those of second dentition; but I will mention a phenomenon which often accompanies the issue of the last great molaris: placed at the base of the coronoid process, at its anterior part, this tooth frequently finds so much difficulty in extricating itself from the bony lamina which covers it, that it frequently remains shut up in the cavity, or takes a direction towards the tongue, after having given rise to various unpleasant symptoms. I was lately called to remove one of these teeth, which, forced to remain in its alveolus, had become anchylosed to the bone, and given rise to fistulous openings, against which all the resources of art had been ineffectually exhausted.

Second dentition is not always accomplished with such exactitude; many circumstances, as I have already indicated, may occur to interrupt it. The permanent teeth sometimes are not formed at the usual time, and those of the temporary set continue to occupy their places. This is a species of irregularity which most frequently occurs, and which may include either the whole series or a lesser number of the teeth. M. Maingault reported to the academy the case of a young man, whose first teeth had

never been shed; and M. Murat met with a case of similar character. All the treatises upon anatomy, indeed, are full of examples of the absence of formation of some of the teeth of the second set.

I know, at this time, a person thirty-eight years of age, who did not lose the second right inferior temporary molaris, till the age of thirty, and which has not yet been replaced.

It is not less common to observe the issue of the secondary, without the fall of the primitive teeth; and this vice of conformation, like the preceding, may occur in any part, more or less extended, of the dental arch. Pfaff has often observed, he says, thirty-three or four teeth; Sœmmering has seen as many as thirty-six. In some individuals, there appears to be a predisposition to the formation of these supernumerary teeth. Various reasons have been given to explain the origin of this variety of irregularity: some have attributed it to the absence of a communication between the alveoli of the first and second teeth, and the defect of pressure, in consequence, by the latter. Without attempting, for a moment, to deny the influence which this circumstance might have, I am inclined to believe that the irregularity sometimes depends upon the absence of the special temporary artery, as M. Serres has observed, and the origin, by a common trunk, of the arteries which supply both sets of teeth.

Sometimes the teeth do not appear in the order and at the periods indicated above. The eruption of the second molaris often occurs before the canine tooth; sometimes the issue of the latter is retarded; indeed, I know an individual in whom it has never appeared.

Sec. 3.—*Development of the Senile Teeth.*

THIRD DENTITION.

If any one fact more than another throws light upon the history of the formation of the teeth, it is assuredly this: that the two dentitions have been calculated according to the ordinary duration of life, and that they will suffice, unless influenced by

circumstances to which our manner of life too frequently gives rise, to assure teeth to each individual during his term of existence. It should, also, be recognised that these two dentitions are all that were originally intended for our use, and that exceptions to this law are extremely rare, appearing like those freaks of nature in which she sometimes indulges, as if to display her power.

Joubert relates the case of a lady of quality, who, having lost all her teeth, cut twenty new ones at the age of sixty years. Sennert mentions a similar case, of a lady of Silesia, who, about the same age, cut twenty teeth, the eruption of which was accompanied by all the phenomena attendant upon first dentition. Eustachius mentions a young man, twenty years of age, whose incisor teeth were replaced, in the course of a year, after they had been extracted. Dufay, a physician of l'Orient, saw, in that city, a man, eighty-four years of age, to whom nature had given, at this late period, two incisors and two canine teeth. Gehlet mentions a canine tooth which was twice renewed. Hunter, also, speaks of teeth which were renewed at the age of seventy years. I found, myself, in the jaw of an adult, immediately under the first small molaris, a new tooth, of which the crown was half formed—both the small molars were in place on this side of the jaw.

Authors, however, are not agreed as to whether we should interpret such cases as evidences of a third dentition. Some believe that they are simply cases of the retarded eruption of teeth of the first or second dentitions; others find it more simple to deny the facts altogether, and to delay forming any conclusion until more light is thrown upon the subject.

On both sides there is error. Can we admit in the case mentioned by Gehlet, where the canine tooth was renewed the third time, the possibility of the retarded dentition? Can any doubt be entertained in the case which fell under my own observation? It cannot be urged that this was not the rudiments of a tooth of a third dentition, for it was placed under the bicuspides, which class of teeth belong to the second set alone.

Why, indeed, does the possibility of a third dental formation seem so remote? Is this anatomical truth more difficult to con-

ceive than the thousand anomalies encountered daily in organs much more important than the teeth? Assuredly not. Let us show ourselves less incredulous, without believing with Fallopius, that the body renews itself to the sixth septenary, and that, consequently, the teeth may be renewed at that period; let us hold ourselves rigorously to the observation of facts.

It will have been observed, that in all the cases of third dentition, mentioned by credible authors, that they have been extremely incomplete: one or two isolated teeth only making their appearance. Accounts of a renewal of the whole dental range are very rare, and even those cases on record of doubtful authenticity. This third dentition, as Hunter justly remarks, when it occurs in persons who have lost all their teeth, instead of being a benefit, is really a serious inconvenience to the individual. Isolated, most frequently, upon the dental arches, and wanting points of support against opposing teeth, they cause irritation, inflammation, and ulceration of the gums, till their removal becomes necessary.

Sec. 4.—*Application of the Development of the Teeth to the Determination of Ages.*

The consideration of the teeth with regard to the determination of the ages of individuals, is not only interesting in an anatomical and physiological point of view, but it has a practical application of much importance. It serves, in legal medicine, to recognise the age of an individual, in the absence of the ordinary proofs. This application of the phenomena presented by the development of the teeth, has enabled Cuvier to fix the opinion of the learned, with regard to two heads of extraordinary size, which were disinterred, one in the environs of Rheims, the other at Billerbeek, in the bishopric of Munster, which were, generally, thought to prove the existence of a gigantic race, at present extinct. An examination of the teeth and alveolar arches enabled this celebrated anatomist to overturn the opinion generally entertained, and to show that the heads not only did not belong to a race of men different from our own, but that they were those of

very young children. We will give, however, the account in his own words:

"The age of a head, however deformed it may have become in consequence of diseases of the osseous system, may always be very nearly ascertained by the number and configuration of the teeth.

"The reason of this, is, that the teeth are not developed like the bones by introsusception, but grow like shells, by simple juxtaposition, and their parts once formed, being no longer subject to inflammation from an internal principle, those diseases to which the bones may be subject do not affect them in the slightest degree; neither are the bones immediately affected by diseases which attack the teeth. Guided by these views in the examination of the heads in question, I found in that of Darmstadt the half-filled alveoli of six teeth on each side, two incisors, a canine and three molars. In the inferior jaw, the left side of which only remained, the alveolus of the third molaris was wanting.

"This first led me to the conclusion that the individual was about six or seven years of age at the time of his death, and that the alveoli remaining were those of the temporary teeth.

"Towards the sixth or seventh year, the first permanent molaris makes its appearance, and at the same time the temporary teeth in the anterior part of the jaw begin to fall, to give place to the teeth which are to succeed them.

"What the alveoli of the Darmstadt head appeared to indicate, the teeth themselves of the head, in the possession of M. Jussieu, seemed to confirm.

"This head, also, had but six alveoli on each side of both jaws; the sixth of the left side of the superior jaw was also absent. This sufficiently proved that it was near the age of that of Darmstadt; but, by great good fortune, two molars, the second of the left side of the superior jaw, and the second of right side of the inferior, were preserved.

"Now nothing was more easy than to determine whether these teeth belonged to the first or second dentition, as the second temporary molaris differs, entirely, in form, from that which succeeds it.

"In man, as in most quadrupeds, indeed, the milk molars have

a more complicated form and resemble the large permanent molars more than those which replace them, and the object of this difference is easily comprehended: as a long time elapses before the appearance of the great molars, and as those teeth are essential to perfect mastication, their form was given to the temporary molars, in order that they might fulfil the requisite formations. Thus, in man, the first temporary molaris has towards the inside of the mouth a large tubercle, and a crest divided into two lobes without; the second has four tubercles disposed obliquely. In the inferior jaw, the first milk molaris has four tubercles a little elevated above the surface of the tooth, and the second five, of which there are three without and two within; each of the latter being a little bilobed. In other words, the second temporary in each jaw resembles the first permanent molaris which rises behind it, and not the one which succeeds it.

"The molars of replacement are the bicuspides of the adult; their crown presents two great tubercles, one within and one without; the tubercles of those of the inferior are a little more indented than those of the superior jaw.

"The roots of these two species of teeth are also very different, and are always shorter and more complicated in the temporary than in the teeth of replacement.

"Guided by these facts, I examined the teeth, and their diminished roots of the head, in the possession of Jussieu.

"The second molaris remaining in the superior jaw had four tubercles and an uneven crown, and, by examining the corresponding alveolus of the opposite side, it was ascertained that it had three short roots. Thus complicated, and occupying the second alveolus from the canine, the conclusion that this is a temporary molaris is inevitable.

"The tooth which had occupied the next anterior alveolus to this, was of the same form, for it left the marks of its three roots in the alveolus. Behind it, was a third molaris, now broken off, but which had left three roots; this could not have been any other than the first large permanent molaris, which appears about the seventh year. It is only about the seventh year, indeed, that three teeth are observed together in the superior jaw, each having three roots; for before this age, the first permanent molaris has

not made its appearance, and a little while after the temporary molars are replaced by the bicuspides, which have but one, or at most, two roots. It is true that the second permanent molaris, which has three roots, then passes through the gum, but the third or wisdom tooth never has so many. Then, as I have said, a little while after the age of seven years, there are but two molars in contact with each other which have three roots.

"The inferior molaris of the head in question had five tubercles upon its crown like a second temporary molaris of this jaw, a little worn away; which fact proved that they had served the individual for mastication during some time. It is true, that if this tooth had been found isolated, it would have been difficult to have determined whether it was the second temporary or the first permanent molaris; these teeth, as I have mentioned above, having very nearly the same form. But under the present circumstances, this supposition would be inadmissible, as there would not then be the ordinary number of teeth in front of it. The two cavities, anteriorly to the tooth, in place, are not two alveoli, but places for the two roots of the same tooth; and the existence of the two roots, separated from the neck of the tooth, proves that these cavities were filled by one temporary molaris, and not two bicuspides.

"The canine, on this side is broken out, and not driven into the substance of the bone, as was thought by M. Jadelot. As regards the incisors, this idea is still less applicable.

"The alveoli of all the incisors are marked, and at their ordinary place, they are half filled, which proves that the teeth which occupied them had been shed.

"The tooth remaining in the substance of the bone, near its inferior face, has its cutting edge very entire, and the points of the crown resemble those of an incisor of replacement. It has, evidently, never been used: for in that case it would have been somewhat worn like the molaris which remained in place.

"From the perfection of the cutting edge of this tooth, and the existence of an alveolus, which is a certain mark that another incisor had preceded it, I am convinced that far from having been driven back into a softened bone by the pressure of mastication, this has been unable to pass outwardly, in consequence

of the hardness and thickness of the bone, which opposed an invincible obstacle to its eruption.

"Near to this tooth, on the interior, another larger cell is situated, which will doubtless be found to contain a tooth if the jaw be broken at this place.

"I am persuaded if the bone were opened in this vicinity more teeth would be found, which were unable to reach the exterior.

"The surface of the jaws, examined in detail, confirm what is indicated by the teeth and alveoli. Behind the alveoli of the incisors are the vestiges of the little holes, which, in the normal condition of the parts, offers passage to the incisors of replacement; these little holes are, however, entirely closed by the swelling of the bone.

"In the superior jaw, very distinct traces, only a vestige of which remains in man, are observable, of the suture which, in animals, separates the incisor from the maxillary bone. The remains of this fissure is of value in determining the situation of the canine tooth; and in enabling us to see that the tooth placed behind it, or the first molaris, had three roots, and was, consequently, a temporary molar.

"If I do not deceive myself, all these circumstances concur to prove, that the heads under examination are those of children who died about the period when the shedding of the teeth takes place, and that this change in their case could not be effected."

ORDER IV.

IMPORTANCE OF THE TEETH IN THE ORGANISM.

The influence of the teeth upon the rest of the organism is two-fold: by the functions which they perform, and by the modifications they effect in their development upon the parts with which they are more immediately in relation. Let us examine, first, the second point, which comes more particularly within the scope of our subject.

ARTICLE I.

INFLUENCE OF DENTITION UPON THE FACE.

It is unnecessary to insist very strongly, upon showing, *a priori*, how great should be the modifications effected upon the face by the teeth. It will be sufficient to state, that these organs protect the cavities of reception, and hold the jaws separated at a proper distance.

The action of the teeth upon the soft parts of the face, reduces itself, in our examination of the subject, to the greater or less tension of these parts, for it does not come within the range of this work to consider the sympathetic affections caused by the development of the teeth. In the fœtus the cheeks are flaccid and make a kind of projection outwards, in consequence of their excess of length, which they hold in reserve to give room to the teeth when they issue from their alveoli. It is this condition of the parts which gives to the face of a new-born infant the disagreeable and almost senile appearance which it presents. The cheeks continue to present this excess of length until the commencement of the eruption of the teeth; and if, before this period, the physiognomy loses its disagreeable character, and assumes that almost angelic expression so apparent in the face of an infant, it is in consequence of a deposition of fat in the subcutaneous tissue, and is not the result of any increase of the teeth.

After the eruption of the temporary teeth the cheeks are less full; the face is more elongated vertically than before, and has a much more agreeable expression.

Up to the time of the completion of second dentition, the cheeks possess a much greater extent from above downwards before, than posteriorly, which gives them a triangular form. After this period they become more square, in consequence of the depression of the angle, and increase of the rami of the inferior jaw.

Finally, in old persons, when the teeth are fallen, the cheeks again become flaccid as in the fœtus, and the face assumes a much less agreeable expression as the fat disappears; the cheeks no longer having, as in the child, their full rounded appearance.

The influence exercised by the teeth upon the maxillary bones is very great, and it is necessary to give particular attention to this part of their history:

The action of the teeth upon the jaws is two-fold: directly, they affect the dental arches; indirectly, the lower border of the inferior maxillary bone—the inferior dental canal—the angle of the jaw—the mental process—the mental foramen—the relations of the condyle and coronoid process—the pterygoid process—the malar tuberosity and the suborbital foramen.

1st. *Changes produced by the Teeth upon the Dental Arches.*—These changes are effected in the form and dimensions of the arches.

The maxillary bones are, really, formed into two distinct portions: that which has an immediate connection with the teeth, and the properly called dental portion. The dental part, to which, only, we will direct our attention at this place, is of less extent than the other. With regard to development, it is always in exact relation to that of the teeth; and, like the teeth, it undergoes a series of modifications in early life, which are very exactly repeated at an advanced age.

The dental portion of the maxillary bone presents itself in the form of a simple trench, almost imperceptible at the period when the development of the germs of the teeth first becomes sensible. A little while after, it is separated into a certain number of alveoli, common to the teeth of the first and second dentitions. Somewhat later, two distinct sets of alveoli for the temporary and permanent teeth are formed. After the eruption of the permanent teeth, it presents but a single range of alveoli for these teeth. Finally after the loss of the teeth, the alveolar portion of the maxillary bones is obliterated, and gradually takes the form presented in the embryo.

The alveolar arches undergo a series of remarkable modifications, with regard to their dimensions, in consequence of the development of the teeth. In height, they follow very exactly the development of the roots of the teeth, as may be inferred from what has preceded. They are, at their maximum of development, in relation to their volume, about the age of five or six years, at which period they give place to the teeth of the first

and second dentitions; before and after this epoch, in inverse proportion, with regard to age, they diminish gradually. Considered in relation to their length, the changes are more complicated; the circumstances of which, it is of importance fully to appreciate.

The extent, in length, of the alveoli, is, necessarily, in proportion, to the number and volume of the teeth, to which they give place. It may be asserted, indeed, without fear of contradiction, that, under this relation, the alveolar arches continue to increase from the beginning of life to the full development of the wisdom teeth; and if they do not decrease from that period in length, it is only because they are maintained by the non-dental portion of the bone, which cannot diminish.

In the adult, the alveolar arches are divided into two portions of equal length, which may be represented by a line drawn in front of the first great molaris on each side. Up to the period of the eruption of the first permanent molaris, at about the fifth year, the alveoli are reduced to their anterior portion; at this period the posterior part exists, but it is much inferior to the anterior portion. At about the tenth year, the posterior portion of the alveolar border is extended backwards to give place to the second large molaris, which, then, makes its appearance. Finally, after the eruption of the wisdom tooth, the two portions are, as I have said, equal in extent.

This simple account of the changes which occur in the alveolar border, in proportion to the development of the teeth, suffices to show that the teeth are the cause of these modifications, and that the changes affect the posterior portion only.

But another question presents itself here, which is a little more complex, and a little more difficult to resolve—it is this: Do the twenty anterior teeth of the second set occupy more or less than, or only the same amount of space, as the teeth which they replace? Or, in other words, when the first great molaris is developed, and takes its place in the dental arch, does that portion of the alveolar border, which is anterior to this tooth, undergo any modifications with regard to length? Hunter first proposed this question, and he decided that the anterior portion of the alveolar border remained unchanged; but his theory, so wisely

adopted, has not met with the assent of all; Blake and Léveillé have advanced a different opinion. This point of odontology deserves to be examined with much attention, as it has a directly practical bearing in regard to the artificial direction of the eruption of the permanent teeth.

The best means, evidently, of deciding this question, is, to measure, carefully, as Delabarre has done, before and after the shedding of the teeth, the distance between the large molars, and the central incisors; and this process gives the same result in both cases. M. Miel, who gave much attention to this subject, and who warmly defended the opinion of Hunter, adds: "The appearance of the second teeth is but a substitution of those which are longer and more capable of effecting the uses of a more vigorous age; their total volume is the same as that of the temporary teeth, the only difference is in their respective size." Another circumstance, upon which M. Miel lays great stress and with much reason, is, that the teeth of those persons in whom the second dentition is premature, are not placed regularly in the arch, but are pressed up against each other, and sometimes present their exterior surfaces obliquely during life, which could not be the case if the anterior portion of the alveolar border were capable of elongation.

The anterior portion of the dental arch, indeed, does not only not undergo any increase at the period when the teeth are shed, but no alteration takes place after first dentition is completed. The drawings, taken from M. Oudet, of the dental arch, of subjects from five to six years, do not show the slightest variation, although this measurement was made in a great number of instances.

The fact of the equality of length of the anterior portion of the dental arch, before and after the shedding of the teeth, has been effectively proved by Hunter and M. Miel; although its invariability, during all the process of second dentition, was not made out by these authors. This, however, has been perfectly established by M. Oudet, in a paper which he read to the Academy, in 1824. M. Oudet proved, first, that when the secondary incisors appeared, they, being larger than those which preceded them, caused an elongation of the alveolar border, proportionate

to their excess of volume, and that the first large molaris is pressed a little backwards; he showed, secondly, that after the eruption of the fourth great molaris, the first is again pressed forwards to its proper place, as there is more room, in consequence of the eruption of the second small molaris, which is much less in volume than that which preceded it.

Finally, to terminate this subject, let us present a consideration which does not appear to have been yet properly appreciated: nature shows, by the manner in which she proceeds in the development of the second teeth, that there is to be no increase of this anterior portion of the alveolar arch, for the canine tooth does not make its appearance until the issue of the first and sometimes the second small molaris, and it is, meanwhile, placed out of the dental arch. If it be admitted, that there is an increase in length of the anterior portion of the alveolar arch, as is believed by Blake, then the cause of this particular arrangement is inexplicable. If the opinion of Hunter be admitted, nothing can be more simple. The secondary incisors, larger than those of the first dentition, having taken the place of the canine, the eruption of this tooth is delayed until sufficient space is gained by the change of the temporary molars for the bicuspides, which are smaller.

After the loss of the teeth, the alveolar arches diminish in length, from behind forwards, and take again the first form they presented. In the child of five years of age they are semi-circular; they are parabolic in the adult, and assume again the semi-circular form in old persons.

Changes produced by the Teeth upon the Lower Border of the Inferior Maxillary Bone.—M. Miel first directed the attention of anatomists to this subject. He has shown that the lower border of the inferior maxillary bone is slightly arched upwards, particularly backwards, in the child and old person, but that it is perfectly horizontal in the adult.

Changes produced by the Teeth upon the Inferior Dental Canal.—In the earlier stages of the formation of the inferior maxillary bone, this canal does not exist; the vessels and nerves to which it afterwards gives lodgment, now occupy the bottom of the groove, which is the rudiment of the canal. This canal

is developed, together with the conduit destined to give place to the vessels of the temporary teeth, when the alveoli are separated from each other In the adult, this canal is placed about the middle of the bone, between the dental and basilar portions. In old persons, after the obliteration of the alveoli, the dental canal occupies the superior border of the bone, but it never disappears entirely. In early life, it corresponds, exactly, to the lower portion of the alveoli; in the adult it is placed a little within them, pressed towards this point, according to Cuvier, by the prolongation of the roots of the teeth. During uterine life, and until some time after birth, the dental canal of first dentition is very large; but from this time it diminishes gradually, and finally disappears entirely, when the fall of the temporary teeth is accomplished.

Changes produced upon the Angle of the Inferior Jaw.—In the earliest periods of life the inferior maxillary is nearly or almost entirely straight; the angle is gradually developed, until the adult age; in old persons it again diminishes. Very obtuse at first, it forms a right angle in the adult, and finally, in old persons, again assumes the obtuse form it presented in the fœtus.

Changes produced upon the Mental Process.—The changes of this part are intimately related to the preceding; when the angle of the jaw is obtuse, as in the child and old person, the mental process projects considerably, and is turned much upwards; when, on the contrary, the former approaches the right angle in the adult, the latter is less projecting, and almost entirely turned upwards.

Changes produced upon the Condyle and Coronoid Process.—The surface of the condyle and the summit of the coronoid process are directed backwards and upwards, in the child and old person; in the adult they present directly upwards. But the most remarkable modifications which these eminences present, are those which result from the changes they undergo in regard to their relative height. In the fœtus, the coronoid process is elevated in all its height above the condyle; in the child, the two parts tend more and more to the same plane; finally, in old persons, they again assume their first relations.

Changes produced by the Development of the Teeth upon the

Mental Foramen.—M. Duval first observed these changes. He has shown that the mental foramen is situated very near to the symphysis, at birth, and is gradually carried backwards, in proportion to the development of the temporary teeth. At birth, this opening corresponds to the inter-alveolar wall of the canine and first molaris. When the temporary teeth are fully developed, it is placed more posteriorly. When the first large molaris makes its appearance, it corresponds to the partition between the two temporary molars; and, finally, when the wisdom tooth has issued, the mental foramen is almost always found very near to the place under the alveoli which separate the first and second molars.

Changes produced by the Development of the Teeth upon the Pterygoid Process.—The pterygoid process is, to the superior, what the posterior border and angle of the jaw are to the inferior dental arch. Both serve as a point of support to the posterior portion of the alveolar arch; both are free posteriorly, and, consequently in a condition to follow all the changes of the alveolar border. That the analogy which is shown to exist between these parts is not founded upon theory alone, the observation and comparison of the changes which they undergo under the influence of the development of the teeth give the most positive confirmation.

In early life, at the period of birth, especially, the pterygoid process, like the posterior border of the inferior jaw, is directed obliquely downwards and forwards. When the thirty-two teeth are fully developed, the angle it forms with the horizon is sensibly right. Finally, after the loss of the teeth of the superior jaw, the pterygoid process takes again its original oblique direction.

Changes produced by the Development of the Teeth upon the Suborbital Foramen.—These changes are analogous to those which the mental foramen of the inferior jaw undergo. At birth, the suborbital foramen is placed above the wall which separates the alveoli of the canine and first molar tooth. When the first dentition is completed, it is placed a little more posteriorly. It is situated above the wall of separation between the two temporary molars, when the first large molaris makes

its appearance, after which time its relative position undergoes no sensible change.

Changes in the molar tuberosity.—The molar tuberosity and the base of the coronoid process of the inferior jaw undergo some important changes under the influence of the development of the teeth. For a considerable time before their eruption, these parts afford a lodgment to the forming molar teeth, which give to them a considerable volume. At birth the molar tuberosity is entirely rudimentary, but, in a short time after, it begins to enlarge, as the first large molar is gradually developed. After the eruption of this tooth the tuberosity still remains enlarged, as it encloses the second and third large molar. After the eruption of the wisdom tooth, the molar tuberosity no longer exists; the alveolar border has no greater extent transversely here than in any other part of the arch; and it is less elevated at this point than in the vicinity of the first large molar.

Changes in the facial angle under the influence of the development of the teeth.—Supported, posteriorly, by the pterygoid processes, the alveolar arch of the superior jaw cannot be developed in any great degree in that direction; and as the elongation it undergoes it is necessary to express by a greater projection forward, which gives a more oblique direction to the facial line of Camper. This takes place in proportion to the eruption of the teeth, and this change removes from the face of the child something of the sprightliness and intelligence which, at first, characterised it.

In the adult, the middle molars of the superior jaw exercise, by their roots, a remarkable influence upon the floor of the maxillary sinus, they raise and render it in some degree flexuous. Some authors have believed that the roots of these teeth were made divergent for the purpose of diminishing, as much as possible, this action upon the sinus. Be this as it may, the shortness of the roots of the teeth on one side and the rudimentary condition of the sinus render its action unimportant in the child. In the adult, on the contrary, every thing in this connection concurs to give it a great degree of importance; the sinus is very large, the roots of the teeth have acquired all their length and are plunged deeply into their alveoli. In old persons, doubtless,

the sinus takes a new development, and its floor is carried back from contact with the roots of the teeth ; the action of the latter, however, upon the floor of the sinus is already diminished by the contraction of the alveoli so that the phenomena is less marked at this time than about the middle period of life.

This action of the roots of the superior molar teeth is sometimes so great, that they penetrate the sinus itself, and give rise in consequence to a number of disorders.

ARTICLE II.

IMPORTANCE OF THE TEETH IN THEIR FUNCTIONAL RELATIONS.

The teeth perform, in the human economy, a part of great and varied importance. They concur in forming a barrier which retains the saliva in the interior of the mouth ; they act in the prehension and mastication of aliments and assist in pronunciation ; they are susceptible of receiving and transmitting certain impressions, and serve under certain circumstances as means of attack and defence.

All the teeth may be employed in the prehension of solid substances, but this is peculiarly the office of the incisors ; these teeth act in an opposite direction upon the body presented to their action, and separate from it a portion more or less considerable. The arrangement of the incisors are remarkably well adapted for the accomplishment of this end ; they have cutting edges at their free extremities, which cross each other like the blades of a pair of scissors. But, on the other hand, placed at the extremity of the lever of the jaws, they cannot exercise any great degree of force upon the bodies presented to them; and when the latter offer much resistance they are necessarily presented to these teeth in small portions, for when the jaws are widely separated, the levator muscles act with diminished power.

The canine teeth serve better to tear, than to divide aliments simply ; their pointed crowns penetrate deeply into the substances offered to them, and, in consequence of the great length of their roots, they are enabled to sustain a great degree of force.

As they are placed nearer the fulcrum of the maxillary lever than the incisors, they act with more power than these teeth.

The molar teeth are rarely used in the prehension of aliments, and their form renders them entirely unfitted for cutting or tearing the food; their assistance is, however, of importance for this purpose, in conjunction with the hands and extensor muscles of the head. But in this act the molar teeth only serve to fix the substance we wish to separate—whilst the two powers, the hands and the muscles of the back of the neck, acting in contrary directions, effect the object. Although the molars do not answer well for cutting or tearing substances presented to them, they are capable of acting with great power, and making strong pressure. For this purpose they are admirably adapted, not only in consequence of their position near its fulcrum of the lever of the jaw, but of the points and depressions of the opposing teeth, which are so arranged that they close exactly within each other, and make it impossible for a body to escape them. To wholly carnivorous animals they are more useful as instruments of prehension than to man; his incisors and canine teeth serving his purpose fully.

But if the molar teeth are of little use for the prehension of aliments, they are not so with regard to mastication; they are indeed most advantageously constructed for bruising and dividing into very small particles such substances as are submitted to their action. Their crowns are large; the summits are furnished with inequalities as was stated above, which alternate and close together in the two jaws, in such a manner that substances taken between them are retained a sufficient length of time to insure their perfect trituration. In addition to this, the molar teeth are provided with roots subdivided into several branches; each of which is received into a special alveolar cavity.

The precautions for the accomplishment of complete mastication have not been confined to the disposition and arrangement of the teeth; the most perfect harmony has been established between the opposing power of the superior and the action of the inferior jaws. As the superior incisor teeth are not required to sustain any great amount of pressure, it was not necessary that the alveolar processes at this point should be very strongly sup-

ported; thus we find them corresponding to the anterior nasal opening. The canine teeth are sometimes required to withstand great force, especially in carnivorous animals, which with these teeth, daily tear their food; and we consequently find that their alveoli are solidly supported against the external orbital process of the frontal bone through the intermediate fronts—nasal column of the superior maxillary. The molar teeth which bear nearly all the brunt of mastication, and are required to sustain the powerful force of the lower jaw, we find strongly supported by the base of the cranium, through the zygomatico, jugal and pterygordian columns.

It is almost unnecessary to remark that the food undergoes the requisite degree of modification only by passing many times under the action of the molar teeth, and that the tongue and lips are engaged in carrying back the aliments which are constantly disposed to escape.

The great advantage which results from the conical form of the roots of the teeth is very apparent; the force that would otherwise tend to bring them in their alveoli, is, by this construction, entirely decomposed. Instead of acting upon the extremities of the roots where the vessels and nerves form the pedicle, the pressure is distributed upon all their surface. It will be remarked, besides, that in proportion to the greater amount of pressure the different classes of teeth are required to sustain, are they provided with roots in greater number and better adapted to the purpose.

The precautions which nature has taken to render perfect the action of the teeth upon alimentary substances are, doubtless, very numerous; but it will be found that none were unnecessary, when the influence of mastication upon digestion in the stomach is considered. When a great number of the teeth have been lost, or when mastication has not been perfect, chymification, accomplished with difficulty, the stomach, irritated by aliments not sufficiently triturated, suffers, becomes inflamed, and disease is developed. Old persons who have lost their teeth are obliged to observe a particular regimen in order to avoid disorders of this kind.

It is only necessary to mention here, to be comprehended by

every one, the influence of the teeth upon the pure and clear articulation of some sounds. All the teeth, however, are not equally important in this relation; the incisors occupy the first place, the canine teeth the next, and the first molars the last. The large molars exercise but little if any influence upon the pronunciation.

The teeth, and particularly those situated anteriorly, not only serve to give clearness and precision to the pronunciation; but they, besides, prevent the expulsion of the saliva from the mouth during conversation. Thus it will be seen that the use of artificial teeth is not always to be considered a luxury or a mere gratification of vanity; in this case they correct a real infirmity, unpleasant to those who are the subjects of it, and unsupportable to all who approach them.

The teeth are also susceptible of receiving certain impressions and transmitting them to the brain; the ticking of a watch may be perceived when placed between them with the case closed; heat and cold, to a certain extent, affect them disagreeably and we are enabled to judge of the qualities of bodies accidentally coming in contact with them. These facts, at first sight, appear to clash with the opinions I have advanced in a former part of this work; but, upon a little reflection, it will be perceived, that this is only an apparent difference.

The phenomena of sensibility in the cases mentioned, are not to be attributed to the osseous substance of the tooth, but to the follicle, the papilla and to the nerves which are distributed upon them. The long portion of the tooth serves only as a means of exciting these nerves, which receive the impressions and transmit them to the brain. In this manner should be understood, almost exclusively, the phenomena of the sensibility of the teeth; phenomena which, it has been said, are never disturbed by the causes which produce paralysis in other organs, *(Robert Graves, Dublin Journal,)* an assertion which appears to me nothing less than established.

It might be supposed that in the ticking of a watch placed between the teeth, the auditive impression is received and transmitted by the dental nerves. But this is not the case; the sonorous vibrations have been communicated by the teeth to the

jaws; by them to the cranium and to the labyrinth, from which the impression is conveyed to the brain by the proper auditory nerve.

Although the teeth in their development exercise considerable influence upon the surrounding parts, they are in their turn affected by them. It appears paradoxical to assert, that the cheeks, the lips and tongue concur to give the teeth their proper direction; this is, however, true. When the lips are destroyed, the teeth take an outward inclination, whilst they incline inwardly, when the tongue is diminished in size. I have had an opportunity of seeing the truth of this latter position established, in the case of a young man who had lost the anterior portion of his tongue.

We may say, then, that the teeth, to a certain extent, are naturally placed between two opposing forces, one acting from without inwardly, the other from within outwardly, and that from this equilibrium results the vertical direction of these organs in the human subject.

The salivary organs, the mucous membrane of the mouth, and the dental glands all exert an influence upon the teeth by their particular secretions, which penetrate, and remains adherent to their surfaces, protecting them from the injurious action of the atmosphere, acids, &c.

ORDER V.

VARIETIES OF THE TEETH.

The varieties of the teeth are very numerous, and like most other organs, the differences all exist according to ages, individuals, and races. With regard to the sexes no variety exists.

ARTICLE I.

VARIETIES OF THE TEETH ACCORDING TO THE AGES.

After the details given, in describing the two partitions, and after what has been said of the progressive development of the teeth, little remains to be added here.

The root of the tooth is always developed in inverse proportion to the crown. In the very young child, the crown is formed before the ossification of the root commences. At an age a little more advanced, the crown of the tooth, is beginning to wear away before the root is entirely completed. In the adult, the crown has lost its points and the root soon attained its full development. Finally, in old persons, the crown is sometimes completely worn away whilst the root still remains almost in a perfect state. The ossification of the tooth commences with the crown and proceeds towards the root, and in the same manner they are destroyed by friction. The wearing away of the teeth commences upon the crown, and as may be readily supposed, first upon the points. The incisors are affected first as they are first developed and come into service before the others.

From what has been said, the reason why the free surface of the teeth, and, particularly, the summits of the crown, have been furnished with a very hard vitreous covering will be readily conceived.

At a certain period, which varies according to the habits of the individual, the condition of the teeth, after their formation and some other causes, the points have disappeared, and the enamel which covered the summit of the crown has been worn away. At this time, the upper surface offers a remarkable appearance; the centre presents a yellowish tint; and the circumference a line of unpolished white; these constitute the ivory and enamel of the crown; the relative disposition of which may now be studied. Before the wearing away has proceeded so far, if the crown of a large molaris is examined, a more complicated appearance will be observed. The enamel is worn away at the elevations upon the tooth only, and a number of white points, corresponding to the indentations of the crown, will be found upon the yellowish bed of the ivory.

The wearing away of the teeth continues to advance with age; and in some old persons, the crown is entirely destroyed. Here a remarkable fact presents itself, which, however, will be readily comprehended, after what has been said with regard to the development of the teeth; although the crown is gradually destroyed, no pain or irritation of the pulp is developed, nor is any opening made into the dental cavity.

It follows, necessarily, from what has preceded, that the degree of destruction which the teeth have undergone, will furnish accurate data for the determination of the ages of individuals. The conclusions drawn from the examinations of the teeth of animals, which exist on one kind of food, are very accurate. In man, however, whose food is as varied as his tastes, and whose teeth are materially affected by the diseases to which he is subject, and which are the cause of modifications that render the action of frictions more prompt, there are but few certain conclusions, with regard to his age, to be drawn from the examination of his teeth after the completion of second dentition. We are enabled, however, to obtain approximative results, as Serres has done, of much importance. He was required to ascertain the ages of the individuals to whom the fossil bones, found in the cave of Dufart, in the department of Gard, had belonged. After having studied them carefully, he says:

"The principal bones I have had to examine, were first, a large number of crania, more or less entire, and, more or less encrusted with calcareous tufo or sandstone; second, a superior maxillary with the right cheek bone, to which a part of the orbital arches were attached; a considerable number of teeth, of all classes, in a most perfect state of preservation. The enamel of these teeth is as brilliant and clear as if they were interred but yesterday; the roots only of the teeth found isolated, the bony sockets having been entirely decomposed, are covered with a very fine yellowish dust, which effervesces strongly under the influence of mineral acids, and which is carbonate of lime. Where the teeth were entirely absent in the jaw, the sockets were filled with earthy and ferraginous carbonate of lime. The teeth were, generally, but little worn; from which fact, we may conclude that the individual to whom this superior jaw belonged, could not have been more than thirty years of age at most; and although the facial line cannot be measured with precision, it is not far from eighty degrees. This fragment then belonged to a young man of the white or Caucasian race.

ARTICLE II.

VARIETIES OF THE TEETH, ACCORDING TO THE DIFFERENT RACES.

The teeth show but little variation with regard to the different races. Negroes have them a little larger, longer and more obliquely directed than ours. Buffon said that the teeth of the Calmoucks are remarkable for their length, and the spaces which separate them; but the more recent observations of Blumenbach have contradicted this assertion.

Care must be taken to guard against the error of considering, as varieties of this kind, those modifications produced simply by the age of the individual, or his particular mode of life. Some have fallen into this mistake in a report upon the examination of the teeth of certain Egyptian mummies, but later developments have rectified these erroneous ideas. The error of classing, as characteristics of the teeth, those modifications which are the result of the customs of certain people only, must also be avoided, as, for instance, that of staining them or filing away a portion of their crowns.

ARTICLE III.

VARIETIES OF THE TEETH OF INDIVIDUALS.

The varieties of the teeth of individuals are very numerous, and may be arranged under four principal heads—according to their number, form, direction, position and structure.

1st. *Varieties of Number.*—We sometimes find less, sometimes more than the ordinary number of teeth. There are fewer when some among them have not been primitively developed, nor afterwards renewed, or when several are joined together. It is rarely that there is an entire absence of all the teeth during life, yet this circumstance has been observed. Baumes says, he saw an adult man, named Vaison, who had never had any teeth. Borelli saw a woman, sixty years of age, in the same condition. In some cases, a portion only of the whole number of teeth have appeared; of which irregularity, Schmitt and Fauchard relate instances. In the "*Ephémérides des Curieux de la nature,*" the case of a magistrate is mentioned

who had never had any except molar teeth. More frequently, however, but one or two of the teeth are absent: a vice of conformation which appears to be hereditary in some families; the absent tooth may belong to any of the three classes.

A deficiency in the ordinary number of the teeth, in consequence of the union of two or more, is an anomaly more rare than the absolute absence of some of the teeth, and the union of all the teeth in the same jaw is still more rare. According to the account of Plutarch, the teeth of Pyrrhus were united in this manner; and Pliny mentions a similar anomaly which was observed in the son of Prusias, king of Bithynia. Other authors, according to Diemerbroeck, relate, that Eriphœus of Cyrene, Pherecrates the poet, and Sicinius, were distinguished from other men by a similar conformation of the teeth. Bartholin says he met with a similar anomaly; and Melanthon, finally asserts, that he saw at Lunenburg, in the court of prince Ernest, a girl who, like Pyrrhus, had but a single tooth, which occupied the whole arch of one of her jaws.

But are these statements entirely authentic? it will be asked. I will not say that such a vice of conformation as the above mentioned is impossible, since similar cases have been observed in our day, although upon a much less extended scale. The incisor and canine teeth more frequently present this species of union by the crown than any other portion of their body. The molars, on the contrary, as M. Oudet has correctly remarked, are more frequently adherent by their roots. M. Toirac recently showed me two cases of a lateral incisor united to the adjoining canine tooth. It is said that the temporary teeth present more frequently than any others this abnormal union. Be this as it may, the teeth seem to offer two varieties of union, judging, at least, from the specimens I have recently examined. Sometimes there is an intimate fusion of the two teeth, the bony substance being common in them; and sometimes they are only joined together by an ossification of the alveolar-dental periosteum. The first variety is peculiar to the crowns, the second to the roots of the teeth. In the first case, the fusion of the two teeth takes place when the tooth is in an embryo state; the two germs are close to each other; the alveolar partition is not placed be-

tween them, or not formed at all; the two germs remain in the same cavity; their two cavities are joined together, and the two papillæ are confounded with each other. From this time the two germs have all the characteristics of one of the molar teeth, and the calcareous laminæ, after having been extended over the whole of this double papillæ, are separated into two parts to form the roots of the united teeth.

The second variety of union is very different from the first, and is not formed till sometime after birth. It is a simple anchylosis, formed by the union of the two teeth with the inter-alveolar partition, in consequence of inflammation of the alveoli-dental periosteum.

The union of the canine with a lateral incisor tooth appears to be of more frequent occurrence than any other; and the reason appears to be very plain, for these teeth are formed very close together, and, from the moment of its formation, the canine tooth, thrown out of the range by the lateral incisor, is strongly pressed by it.

The excess, in number, of the teeth, depends more frequently, as I have observed, upon the persistence of the deciduous teeth. Supernumerary teeth also constitute this species of irregularity; they appear either isolated or in a complete series, and almost always behind the permanent teeth. Boudet has observed the two last superior molars doubled; and Plouquet, Camper and Sœmmering have observed five molars well ranged in the inferior jaw; the first in his own case, the second in an inhabitant of Java, and the third in an European.

2d. *Varieties of Form.*—The varieties of this kind, not dependent upon a morbid cause, are much less frequently met with than the preceding; they occur either in the crown or the roots of the teeth. They depend, very commonly, however, upon the persistence of the temporary teeth. One of my friends retained deciduous molar teeth, of the right side, until his thirtieth year; at which age, he had, in the lower jaw, seven large molars, and but three small ones.

3d. *Varieties of Direction.*—Anomalies of this class are sufficiently rare; the teeth sometimes take an oblique direction; are sometimes placed horizontally, and more rarely they are com-

pletely inverted. The obliquity of direction is sometimes so great, according to Sœmmering, that the existence of a double range of teeth has been supposed.

Sœmmering saw an incisor tooth occupying a horizontal position, the crown presenting forwards. Albinus observed an anomaly of the same character, with the crown presenting backwards.

Albinus and Sandifort have mentioned instances of the complete inversion of teeth; the former of a superior incisor, the latter of a second molars, which remained enclosed in the maxillary bone.

4th. *Varieties of Position.*—The teeth are sometimes found, in consequence of a vice in their direction, removed from their position in the alveolar border, and carried either towards the palate, towards the maxillary sinus, or some other point; a fact which surgeons should always take into consideration, when called upon to make a diagnosis of a tumor developed in the vicinity of the dental arches. Professor Marjolin and M. Duval removed a tumor of this description, which was situated upon the inferior maxillary bone entirely without the alveolar arch; and I have had occasion myself to operate upon a female who had a dental tumor in the palatine region.

Case.—A country woman, forty-three years of age, entered the hospital Beaujon; there were two fungous ulcerations, one upon the nose and the other on the right cheek, with hard surfaces turned outwards, which caused troublesome, lancinating pains. She said she had first suffered pain from this affection about eighteen months previously. In examining this patient, attentively, I remarked a peculiar modification of the voice, (she spoke as if a piece of money were lying upon her tongue,) which directed my attention to her mouth. I immediately discovered on the left side of the roof of the mouth, a tumor of the form and size of half of a very large walnut, bounded externally by the alveolar arch, passing the median line by its internal part, extending from before backward, from a point placed at the extremity of the corresponding canine tooth, almost to the velum pendulum palati. It was moderately hard, indolent and prevented the patient from articulating clearly. The mucous membrane was

healthy at the level of the tumor. I learned afterwards, that one of the molars had been extracted and that the others had never made their appearance; this conclusion at least was drawn from the very unsatisfactory history of the case given by the patient.

The carcinomalous nature of the ulcers upon the nose and cheek, compelled me to make an unfavorable diagnosis upon the tumor, which I believed to be of a malignant character. Professor Marjolin agreed with me in opinion, and it was determined that the tumor should be removed and the ulcerations of the face cauterized. I informed the patient of this decision, and as she raised no objection, a day was appointed for the operation.

Not knowing precisely the superior limits of the tumor, I determined to attack it from before backward with the gouge and mallet, intending to carry the stroke through the whole thickness of the palate, if during the operation it appeared to be necessary. Bistouries, saws of suitable form, and cauterizing instruments were provided. The patient was placed upon a bed, a little lower than ordinary, with the head thrown slightly backward, and the mouth kept open by means of a wedge of cork placed between the last teeth of the right side. I made a crucial incision upon the tumor, and dissected out, as rapidly as possible, the flaps I had made. It was then my intention to remove the osseous portion with the gouge, but in sponging out the tumor, I discovered in its centre a white and shining body. In examining it with my finger, I found it was moveable, and taking hold of it with the forceps drew out, not without some difficulty, a molar tooth with three short roots, the crown of which was of the form and size of the first large molars. I examined the wound again with my finger and discovered another tooth which I also drew out. This was not so large as the other, but was multicuspidated like the temporary molars. The great surprise of myself and assistants may be readily imagined. I interrogated the patient, and it was then that she gave me the information of which I have spoken, through the obscurity of which I believed myself able to perceive that the second molar and the canine teeth had never appeared. For any thing more it was unnecessary to torment the patient with questions;

the teeth I had extracted spoke a language more clear than any which she could hold; they had all the characteristics, one of the second molar of the first dentition, the other of the first permanent large molars. It was then, incontestible, that these teeth, taking an inward oblique direction, had pierced the internal alveolar wall, and being placed between the mucous membrane and the bone, had given rise to the tumor.

When the operation was completed, I cauterized the bottom of the wound, both for the purpose of suppressing the hæmorrhage, which was considerable, and of preventing the recurrence of the fungous growth, the character of which I doubted, in consequence of the evidently cancerous appearance of the ulcers upon the face.

In a short time the wound of the palate was completely healed; frequent cauterization with the nitrate of mercury promptly produced a healthy action in the ulcers upon the face, and the patient left the hospital perfectly cured two months after her entrance.

The teeth have been sometimes found in parts of the body very remote from the mouth, in the ovaries, or in other portions of the genital organs. Blumenbach, Ruisch, and Mochsen have cited instances, and a case of this kind has fallen under my own observation. Generally, such teeth have been found with hair and fatty matter in fibrous or fibro-cartilaginous cysts. Sometimes they have been seen implanted in true alveoli upon the portions of bone, and such was the condition of the formation in a case I observed, which is so very curious, that I will transcribe it.

A woman, aged twenty-eight years, scrofulous in her infancy, but afterwards healthy, and regular in her periods, married at eighteen; was affected after her fourth accouchment, with leucorrhœa, which varied in abundance. The general and local remedies were administered, but as they did not produce the usual effects, an examination of the genital part was made, and a tumor, which broke by the pressure and discharged a puriform liquid, was discovered in the vagina. The leucorrhœa being complicated with pain and spasmodic action, we examined the vagina anew, and ascertained, upon the left su-

perior part a hard body which caused pain to the husband during coition. The woman, notwitstanding the existence of this tumor, had been delivered of her fifth infant, which, at birth, bore upon its left cheek a recent excoriation. The patient was brought to Varsovie, and a more careful examination enabled M. Jasinski, and a number of other physicians, to ascertain, that the hard body felt in the vagina was situated between the rectum and vagina, and the projection it made into the latter was in consequence of the destruction of a portion of its wall. The disorders caused by the contact of the sharp surface of this body with the matrix, caused M. Jasinski to determine upon its removal. He took hold of the hard body with the ordinary polypus forceps, but they slipped off at every attempt he made to extract it. Five days after, with a stronger and more suitable pair of forceps, he extracted a well formed molar tooth, which had three roots and a slightly squared crown. Three other incisor and molar teeth were extracted without the loss of much blood, or causing violent pain. These teeth appeared to have been implanted in a bone which could be felt with the finger, but which was so firmly fixed, that, as it did not come into contact with the vagina or uterus, it was allowed to remain.—*Græfe and Walters' Journal.*

It is evident in all these cases that the anomalous formation is a fragment of an extra uterine fœtus; but it is curious to observe the growth of the teeth continue after the death and atrophy of the fœtus; the materials being furnished by the mother to whom the cyst is attached.

Other varieties of position of the teeth consist, essentially, in the transposition of these organs, and a true error of place. Dr. Oudet saw many times the canine tooth occupying the place of the lateral incisor, and the reverse. He also observed a similar transposition of the first molar and canine teeth.

The teeth have sometimes been found entirely unconnected with the alveoli, and retained in the thickness of the mucous membrane of the mouth. Hunter relates a case of this species of anomaly.

"I have seen," said he, "in a young subject, two central incisors of the superior jaw, the roots of which were only suf-

ficiently long to be held in their position by the gum to which they adhered. In examining the jaw, I could discover, at this place, neither alveolar process nor alveolus. It is not easy to explain this phenomenon; these teeth perhaps were not formed in the jaw but in the gum, and perhaps the roots were destroyed. The structure of the teeth appeared to favor the former hypothesis; they were not of the temporary class, and since they did not penetrate beyond the gum, it is reasonable to conclude that they never had roots. The extremity towards the gum was furnished with little round and uniform eminences, each having in it a little hole, a narrow canal of communication with the crown of the tooth, which was quite well formed."

Miel, also, relates many instances of the same kind: "Some years ago," says he, "I extracted from the right side of the superior jaw, between the second molar and the wisdom tooth, at the place where the gum prolongs itself into a point, a little dental body, which was not, however, shaped like the ordinary teeth. As it was too short to have reached the maxillary bone, this tooth was contained in the tissue of the gum where it was formed out of the alveolar system. This tooth issued from the thickness of the gum, presenting towards the mouth its longer portion, whilst the smaller or more pointed part penetrated the membrane itself, to which it adhered. It incommoded the individual, and was on that account extracted."

CHAPTER II.—*Comparative Anatomy of the Teeth.*

The invertebrata are almost the only animals whose teeth can be compared to those of man. The parts which serve the purpose of teeth in the mollusca and constacea, and other invertebrata, are rather horny or calcareous indurations of the mucous membrane, than true teeth.

This observation, however, is rendered almost unnecessary by the definition given of the teeth at the commencement of this work, and I only make it here to give the fact a new confirmation. It is my intention, after having examined the four great classes of the *animalia vertebrata*, for the purpose of showing

the characters of their dental systems and indicating the differences existing between them and man, in this relation to make some mention of the masticatory organs of the invertibrated animals.

ORDER I.

TEETH OF THE MAMMALIA.

The minute details given in examining the teeth of man, the first of the mammalia, will render unnecessary an extended general description of the teeth of these animals.

The mammalia, with a very few exceptions, are provided with teeth. The *fourmillie*, *pangoliu* and *echidna*, are the only animals of this class entirely deprived of them. The order *edentata*, to which these animals belong, is far from meriting this name, for if they are not all well supplied they are not entirely deprived of teeth, as, for instance the *ai*, the *ornithorynchus*, and the *orycterope*. Some animals, which appear to be entirely deprived of teeth, have them during a part of their life-time; M. Geoffroy St. Hilaire, discovered them in the fœtus of the *balœna* an animal which, before his time, was supposed to be unprovided with teeth during life.

The number of teeth in the mammalia varies considerably, but less than the other vertebrata. More than 190 are never found, and this great number only in the dolphin; the Peruvian dolphin has 190; the dolphin of the Ganges 120; the *delphinus frontatus* 92.

The teeth of the mammalia are always sustained upon the maxillary or inter-maxillary bones, and are received into proper alveolar cavities. Some zootomists have stated that the *ornithorynchus* and *hyperoodon* are furnished with palatine teeth, but it seems to me that they have mistaken for dental bodies, those callous eminences found upon the palatine membrane of these animals.

The mammalia are particularly distinguished from each other by the form of their teeth, and it is under this relation that it is most important, perhaps, to study them closely.

The human teeth, as has been seen, were naturally divided into three parts; the crown, the root, and the neck; but this division is not applicable to the teeth of all the mammalia; the *rodentia* and *probescidia* have certain teeth which are covered with enamel over their whole extent, for which reason they have been said to be without roots; this is a bad distinction, however, since these teeth have a part implanted in alveolies which constitutes a true root. Be this as it may, the teeth of the mammalia have been divided into those with and those without roots.

Those teeth deprived of roots, as the incisors of the *rodentia*, the tusks of the *hippopotamus*, *elephant*, &c. have a conical form, and are much greater in length than the other teeth. The cavity is also conical and the base of the cone which it represents is the part most deeply buried in the follicle. This cavity does not, as in the human teeth, close around the base of the pulp, which is not pressed, and the functions of which go on, unimpeded at any time.

The teeth provided with true roots, similar to those of the human dental organs, have, like them, a cavity expanded in the crown, but more or less narrowed in the roots and terminating at their extremities by a small opening. This cavity, in animals, as in man, shuts up and embraces closely the pulp in such a manner as to throw gradually increasing shackles upon its action.

The teeth of the mammalia have been again divided, very properly, into *simple compound*, and *semi-compound or mixed.*

Those classed as simple, like the human teeth, offer no anfractuosity of the external surface, and have their crown formed of a regular shell of ivory covered with a plain and even lamina of emanel.

The external surfaces of the compound teeth, on the contrary, present so many sinuosities that they appear to be formed of several teeth joined together, and it will be found that in sawing them across, the several substances of which they are composed will be passed through many times. The anfractuosities of the surfaces of the compound teeth are filled with a substance peculiar to the teeth of mammiferous animals, called cement, which I shall, presently, examine more particularly.

The cavity of the compound tooth is sub-divided as many times as the tooth itself presents parts joined together by the cement. Their pulp has the same configuration as that of the human teeth, but there seems to be a certain number of secondary pulps joined together by a common base. For the rest, we will give Cuvier's description of the grinding tooth of an elephant.

"It has (the germ) in each animal a peculiar figure. To obtain a correct idea of that of the elephant, let the bottom of the capsule, representing the base, send off little parallel walls toward the part of the sac, next the buccal extremity of the alveolus.

"These little walls are adherent to the bottom of the capsule, whilst their opposite extremity or summit is free.

"This free summit is much thinner than the base, and it may be called the cutting edge. It is, moreover, deeply cleft into many points or sharp denticulations.

"The substance of these little walls is soft, transparent, very vascular, and appears to partake very much of the nature of gelatin. It becomes hardened, white and opaque from the action of alcohol.

"The semi-compound teeth are those in which the intermediate substances penetrates only to a certain depth, the base being simple.

"A good idea of the compound teeth of animals may be drawn from the human molar teeth, which have a simple crown and compound root, whilst the former have generally a simple root and compound crown. Suppose the roots large human molars, covered with enamel, and joined together by cement, and you have a type of the compound teeth of other mammalia."

The teeth of the mammiferous animals differ as much from the teeth of man in the conformation of their crown as their species of food differs from his. Studied under this relation, they furnish very numerous zoological characteristics, upon the importance of which, modern zoologists, particularly M. Blainville, have justly insisted. It will be sufficient to say at present that, in proportion as the animals are carnivorous and ferocious, the teeth are remarkable for their greater projections, their pointed and cutting edges; and that, on the contrary, as the dispositions

of the animals are more peaceable, and their food of the vegetable kind, their teeth become proportionately enlarged and flattened upon the upper surface. The human teeth occupy a middle place between these two opposite organizations, as he is confined to neither a vegetable nor animal diet. The differences of conformation of the grinding surfaces of the teeth of these animals are in relation to their species of food. In the horse, for instance, who is removed as far as possible, in his nature and habits, from the carnivorous animals, instead of points, depressions will be found upon the grinding surfaces of some of the teeth.

All the species of the teeth of man are found also in the other mammalia, but they are not all relatively disposed in the same manner. In number they vary according to the families. I can only give a very general view of the subject here, afterwards it will be seen how much is confirmed by particular details. The determination of the teeth of the mammalia is often a difficult point, and one which demands the close attention of zoologists.

The teeth of the mammalia, like those of man, are essentially composed of two substances, the ivory and enamel. The ivory, as in man, forms the principal and central part, the enamel the cortical part of the crown. The ivory is formed of concentric lamellæ, and the enamel of perpendicular or oblique fibres, proceeding from the external surface of the ivory by one extremity. But to these two essential substances, composing the teeth of the mammalia, another is added, the cement, called by Tenon the osseous cortical substance. There is, besides, in the teeth of these animals that confused calcareous crystallization; a kind of internal tartar which Rousseau and Desmoulins, from its resemblance to the pudding stone, called *poudingoido.*

The cement is found only in the compound or semi-compound, and never in the simple teeth of the mammalia. It is placed between the divisions of these teeth, and fills the interstices to the surface of the tooth. The cement is the least hard of the three dental substances; it is dissolved less readily in alcohol, and blackens sooner when exposed to the action of the fire than the enamel.

The cement exists in such quantities in some of the teeth, as for instance, in the grinders of the elephant, that it forms about

half of their whole mass. It is unorganized, and seems to be a kind of tartar crystallization. According to Tenon, it is produced by the ossification of the internal membrane of the follicle, which, according to Cuvier and Bichat, as I have before stated, is reflected upon the pulp, and under which the tooth is primitively formed. According to Cuvier and Blake, on the contrary, this substance is produced by the same organ, which secretes the enamel after the latter is formed.

Be this as it may, the analysis of this substance, taken from the tooth of a *capybard*, has furnished the following results: animal matter, 43.01; phosphate of lime, 52.94; carbonate of lime, 4.05.

The follicle of the teeth of mammiferous animals is disposed like that of man. Indeed, it must be admitted, that the description given of the follicle of the human teeth was drawn from a particular examination of those of larger animals, as the ox and elephant.

There is little to be added here to what has been said of the embryo formation of the human teeth. The teeth of animals are developed in a manner precisely similar; a third substance is formed, however, over the other two, which make up their body to guard them from the friction to which they would otherwise be exposed.

The teeth of these animals do not all resemble each other with respect to the period of their growth. In all, it is true, the development goes on by the formation of successive concentric laminæ; but in some, as in man, this increase is limited, whilst in others it continues during life. Those which are limited in their growth are more common, the others really constitute an exception.

This indefinite growth of the teeth is almost always confined to the incisor or canine teeth. We rarely observe a molar presenting this remarkable character. The reason of this is easily understood; as the molar teeth are intended for the trituration of the food, it is consequently necessary that the distance between the antagonist teeth of this class should correspond to the separation of the jaws. "As the functions canine and incisor teeth are to divide the aliments, they may attain to great size

without becoming a source of inconvenience; indeed, this increase of dimension renders them more useful in fulfilling another function.

It is evident that those teeth, of which the growth continues during life, have the means of furnishing a constant supply of enamel, and in this respect differ from the human teeth; they are reduced, indeed, to the part which represents the crown of the latter. In order that this continual elongation might go on, without a change of character, it was necessary that the parts should be kept in constant relation with the organs which secrete the two substances of the tooth, and such is the case. As in the description of the human teeth the causes which limit their growth was explained, we will now consider the causes of the indefinite increase of some of the teeth of mammiferous animals.

The *rodentia*, *pacydermatu* and *cetaceæ* are almost the only animals of this class which have teeth possessing the property of increasing during life. These teeth are classed with those which have no roots; their internal cavity is conical in form. The pulp, conical also, rests, by a large base, upon the bottom of the alveolus, whence it receives its vessels and nerves, and not through the medium of a pedicle. In consequence of this arrangement, it is evident that the bony matter can never surround the pulp in such a manner as to interrupt its functions, and there is no reason why it should not continue to secrete this substance during life.

When the teeth have acquired a certain degree of development in their follicles, in mammiferous animals as well as in man, their eruption takes place, and dentition is accomplished. The period at which this eruption takes place, and the manner in which the teeth of these animals are shed, is not perfectly known; and here, particularly, the importance is felt of having a fixed knowledge of the changes which take place in human teeth.

The order in which the teeth of the mammalia appear like those of man, is from before to the posterior part of the mouth. They are divided with regard to their duration into deciduous and permanent teeth, as in man few remain during life. But

how do the first and second teeth in these animals succeed each other? This is an important point to determine. In most of the mammalia, the change takes place from below upward, as in man; in others, from behind forwards, as Pallas has demonstrated in the elephant.

Let the order in which the teeth are shed be what it may, the primitive tooth is atrophied in proportion to the growth of the second tooth. Anthropotanists have, principally, attributed the destruction of the roots of the temporary teeth to the pressure of the secondary teeth. I have advanced the opinion in a preceding part of this work, that it is caused by the destruction of the vessels which go to the temporary teeth. This view is the only one confirmed by comparative anatomy. In the elephant, indeed, as the teeth succeed each other from behind forwards, no pressure can be exercised upon the root of the tooth, which soon after falls. Yet, as Cuvier remarked, the same phenomena which occurred in man, occur also in the gigantic animal.

The number of dentitions is not limited in some of the mammalia as it is in man. Some of them, in which these changes have been well observed, the elephant among others, according to Corse, have their molars renewed as many as eight times. We may conclude, however, à priori, that the renewal of the teeth will be proportioned according to the life, more or less long of the animal. Nature, indeed, has but two methods of assuring the teeth of animals, either to replace them by others when they are worn away, or by a continual deposition of new matter at the base, in proportion as they are destroyed by friction at the opposite extremity.

Whatever precautions nature may have taken to render the teeth hard and resisting, whatever the care with which she has deposited the enamel upon the grinding surfaces of the teeth, they must yield to time, and be destroyed, more or less completely destroyed by the frictions to which they are exposed. The influence of the peculiar regimen of animals is particularly apparent upon the teeth; that kind of food which requires their action in a contrary direction, to effect perfect trituration from without inwards, as in ruminating animals, from before backwards, as in the *rodentia*, destroys them in the greatest degree. The

percussion of the crowns of the teeth, such as occurs in ordinary mastication, affect them but little. In laborious or granivorous animals, the grinding action necessary for the trituration of their food wears their teeth rapidly away, whilst carnivorous animals preserve the points and cutting edges of their teeth to the end of life. The influence of friction in the wearing away of the teeth is very apparent in the sloth; in this animal, according to Desmoulins, the teeth in the two jaws are of unequal size, and, as they grind their food like the *rodentia*, the smaller dental range traces a furrow upon the larger one. The lines upon the teeth of animals which grind their food, indicate the direction in which the friction is habitually exercised; in the *ruminantia* they are transverse; in the rodentia antero-posteriorly.

Another phenomenon, not less curious, with regard to the physiology of the teeth, is now apparent. We know that it is necessary for the surface of a mill-stone, in order that it may subserve the purpose for which it is intended, should be rough and unequal; and that, after having been used for some time and worn smooth the miller is compelled to *repick* it to supply it anew with its asperities. This same process takes place spontaneously in the molar teeth, the true buccal mill-stones of the large mammalia. The crowns of the teeth are formed of substances of unequal hardness, which are not equally capable of resisting frictions, the first effect of which is to wear away the original asperities presented. But when this is effected, the ivory of the tooth, less resisting than the cement, and still less than the enamel is worn away sooner than the other parts and new inequalities are formed, the teeth in this manner, repicking themselves. Under this relation, we at once apprehend the importance of the mixture of the three substances of the compound teeth, and why, also, the compound teeth are always molars.

The incisors of the *rodentia* are always much more worn away behind than before, and always present a cutting edge; as the enamel is thicker anteriorly than posteriorly, this is a natural consequence.

The teeth of certain animals are worn away unequally; posterior teeth of the elephant are less worn than those more forward.

But of all among the practical applications which have been made of this fact, there is none more beautiful, and at the same time more useful than that by means of which we are enabled to ascertain the age of the horse. We are particularly indebted to Tenon for the knowledge we at present possess with regard to this subject.

"In this animal," says Cuvier, "the milk incisors make their appearance about the fifteenth day; four of middle teeth or gatherers fall at thirty months, the four adjoining at forty-two, and the four external or *conis*, at fifty-four.

The permanent *conis* do not grow as rapidly as the other incisors, and it is by them principally, that we are enabled to ascertain the age of the animal.

"In the centre of these teeth, filled with blackish tartar, is a hollow, the edges of which, in proportion as the tooth issues from the gum, are worn away by contact with the antagonist tooth; it continues to diminish in size from the fifty-fourth month to the eighth year, when it is entirely effaced.

"The hollows in the other incisors are much sooner effaced, so that we are enabled, with regard to the incisors to judge of the age of the animal only by their length, as they increase indefinitely.

"The first back molar appears at eleven, the second at twenty months; at thirty-two months the first temporary molars fall; the third at three years, and it is not till the fifth or sixth year that the last back molar appears.

"The two first molars of each jaw, and on each side about the eighth day; the following at twenty; the small or anterior molar at five or six months.

"The deciduous molars are longer antero-posteriorly than those which succeed them, and the latter lose their dimension in this sense as the back molars issue and press upon them; thus, crowns of the teeth of a young horse are oblong, whilst in the old horse they are square."

To return, the horse as most of the ruminant animals, has three milk and three back molars; the temporary teeth are more narrow than those which replace them, but have the same form, save that the last inferior resembles the last back molar.

As regards the order in which they make their appearance, it will be observed, that the third permanent molar makes it appearance after the two first back molars, and, indeed, judging from the proportion in which they have been worn, after the third.

In the *quadrumana* the teeth are arranged very much like those of man, the number is exactly the same with a rare exception, observed upon some species ; the mycetes and atèles, have a small molar more. The teeth of the quadrumana are arranged precisely like the human teeth, with perhaps but a single exception; in the *ouistiti* the dental arch is terminated by a small molar.

We begin to perceive the teeth, already, in the ape, lose some of the most marked characters of the human teeth ; their points are, particularly in certain species of *makis*, which are somewhat carnivorous, more developed, the canine is more pointed than, and a little more elevated above, the rest of the teeth.

The order *insectivora* forms, with regard to the teeth, the natural transition from the quadrumana to the *carnivora.* The individuals composing this order have teeth varying in number from 28 to 44. The Peruvian *cephalote* has 28, and the mole 44; between these two extremes there are numerous varieties.

These variations affect always the molar or incisor, never the canine teeth of which there are always two in each jaw.

The points of the teeth are more fully developed in the insectivora than in the quadrumana ; the shrew mouse, the fourth false molar of which has a cutting point like the *carnassierè* of the following order, is a remarkable illustration of this fact.

The incisors are well developed in some of the insectivoræ, in the shrew mouse there are three, but the *mégadermes* and *taphiens* have none at all.

Amongst the carnivorous mammalia much analogy exists under the relation of their teeth. The molars only present any difference, all have twelve incisors and four canine teeth. The molars of the carnivora are divided into two classes, the *false* and the *tuberculous carnassiers.* The false molars are large and have several roots. The superior carnassiers have three lobes and a blunt heel within ; the inferior carnassiers have two pointed and cutting lobes without the heel.

The genus *felis* furnish a type of this order as regards the teeth. The bear is not so well distinguished as a carnivorous animal, as it feeds upon flesh only from necessity. The carnassier is small and its anterior lobe is almost effaced. The tubercles are situated like those of the *rodentia*. The seal has from four to six incisors above and four below, their canine teeth are very pointed, and their jaw teeth which are twenty, twenty-two, or twenty-four in number, are cutting or conical, which last disposition may be considered as a transition to the teeth of the cetacea.

Amongst the *marsupials*, some, the *didelphi* and *dasyuria*, have small incisors in each jaw, canine teeth very long, back molars covered with points; they partake indeed of all the characteristics of carnivorous insectivoræ, and live upon the same kind of food. Others, the *phalangers* have below, two pointed incisors, and six smaller ones above; their superior canine teeth are very long, but those in the inferior jaw are so small as often to be hidden by the gum, and sometimes disappear altogether. The kangaroo have no superior canine teeth, and have the middle incisors equal to the others. The koala have in the inferior jaw two long incisors without canine teeth, and in the superior jaw two long middle incisors, some small lateral and four small canine teeth. The wombat under the relation of its teeth is a true *rodentia*.

The canine teeth are absent in the *rodentia*. The incisors are four in number, generally two in each jaw, and separated from the molars by a considerable space. These teeth are long, strong, of the species, which increase indefinitely, and are more thickly covered with enamel before them posteriorly. In consequence of this peculiar arrangement, the incisor teeth of the rodentia preserve a sharp cutting edge during life, notwithstanding the great degree of friction to which they are exposed. The molar teeth have very irregular surfaces, and the terminal inequalities generally form transverse lines, such as we observe in the same class of teeth in the elephant.

The individuals of the mammiferous order, called *edentata*, are not entirely deprived of teeth, as their name would indicate; they have no incisors, and all except the sloth want the canine teeth. The *fourmellier*, *panzolen* and *echidne* are the only animals of this order entirely deprived of dental organs.

The canine teeth of the sloth are longer and more pointed than his molars.

The molars of the animals of this order vary in number very considerably; the *priodontes* have from forty-eight to fifty above, and forty-eight below. It is remarkable that all the edentata have a larger number of molar teeth in the superior than in the inferior jaw, with the exception of the *taton*, which has sixteen in each jaw.

The grinding teeth of the edentata are nearly cylindrical. They are cylinders more or less perfect, simple, or joined two and two together, and sometimes formed of a single substance. Their growth, like the incisors of the rodentia, is indefinite; and, indeed, it is easily conceived how this must, of necessity, be, as the cylindrical tube is as unable to enclose and press upon the pulp as the conical cavities of the teeth of the rodentia.

The ornithorynchus has no true teeth, but their place is supplied by a horny substance. The form, according to M. Blainville, is square, and there are four of the same kind in each jaw. They are flattened, and the base is irregular and moulded upon the bottoms of the alveoli.

The *probescidia* have no incisors, properly so called; their place in the superior jaw is occupied by their enormous tusks, which are classed amongst teeth without roots, and are capable of an indefinite growth. Their molars are not very numerous; sometimes there are four, sometimes eight, and sometimes twelve. Cuvier says, that in all the elephants he had an opportunity of examining, he found three molar teeth, an anterior one upon the point of falling, a middle one in perfect condition, and a posterior rudimentary one; so that the elephant has but two perfect molar teeth in each jaw at one time. These enormous teeth are of a quadrilateral form, and have upon their grinding surfaces transverse parallel crests united by cement. These crests are notched in teeth which are not much worn. In the old probescidia, they present variable lozenge shaped figures in the African, and narrow and festooned ribands in the Indian elephant.

All the other *pachydermata* have teeth of a much more varied character than the probescidia. Their incisors are generally simple and cutting. Their canine teeth sometimes resemble the

ordinary teeth of this class; sometimes they make formidable tusks, and are sometimes altogether absent. Their molar teeth have a large irregular surface, and well formed for the purpose of grinding their food.

The horse, particularly, has six incisors above and six below; four canine and twenty-six molar teeth, fourteen above and twelve below. The incisors are remarkable in forming a very regular semi-circular curve in young horses. Those in the centre are called the gatherers, the adjoining one the middle, and the external one the coins. Their crowns are all hollowed into a funnel shaped cavity, the base of which presents towards the free extremity of the teeth, and in which there is an accumulation of blackish tartar. This cavity is gradually effaced, as I have already mentioned, by the influence of frictions. The canine teeth are called tusks; they become blunted as the animal grows old. It is a remarkable fact, that in the mare the canine teeth are generally absent. The molars have a prismatic form, and present irregular elevations which cross their grinding surfaces.

The ruminantia have incisor teeth only in the lower jaw; they are eight in number. The canine teeth are generally absent; the camel, lama and kid are, however, furnished with them; the stag has them only in the superior jaw. The molar teeth are formed of double parallel crescents, their grinding surfaces presenting longitudinally, which are rapidly destroyed by friction.

Finally, the *cetaceæ* are, of all the mammalia, the best provided with teeth, at least with regard to number. Some dolphins have as many as one hundred and eighty or ninety. It is that, on the contrary, the *hyperoodon* has but two, the *narwal* but two, sometimes only one, and the *balæna* none at all.

The incisors are generally absent in this order of mammals; the *dugong* is almost the only individual furnished with them, they have them, however, well developed. The canine teeth are entirely wanting. The molars are mostly conical and pointed. Those of the *manatus*, however, are flattened on their grinding surfaces, and are surmounted by two transverse ridges, resembling the grinding teeth of some of the pachydermatæ, particularly the *tapir*.

The *balæna* has no true teeth, but they are replaced by horny productions, which constitute the *fanons* or barbs. The fanons are inserted upon the concavity of the palate, and are directed perpendicularly downwards. They are very numerous; as many as a thousand have been counted in the free whole of fifteen feet in height. Each is formed interiorly of a layer of horny fibres, which are covered by two laminæ, finer and closer in their structure, and in which the horny fibres are not so apparent. The fibres come out from between the laminæ, and form a free fringe upon all the inferior and internal border of the fanon; so that all lateral parts of the palate, which are above the tongue, are covered with a hairy fringe. The fanons are inserted in the follicle of the gum, in which the mucous membrane is very vascular.

The fanons, as will be at once perceived, are more analogous to the hair than the teeth. But if the balæna is not furnished with teeth in the superior jaw, the observations of M. Geoffroy St. Hilaire have demonstrated that they exist in the fœtus in the furrow which represents the inferior jaw. These teeth, according to M. Blainville, are simple and conical like those of the cachalot.

ORDER II.

OF THE TEETH OF BIRDS.

The definition of the teeth which I adopted at the outset, taken from the new edition of Cuvier's Comparative Anatomy, should exempt me from treating of the beak of the bird; from the labors of M. Geoffroy St. Hilaire, with regard to this subject, and the desire to present a complete view of the teeth of vertebrated animals, or the organs which represent them, however, I am determined not to pass them by.

Rigorously speaking, the beak is, to the bird, an organ of prehension and mastication, and may become a powerful offensive and defensive weapon; but with relation to form and structure, they resemble much more the claws and nails than the teeth.

It is only a horny body which nature has substituted for the teeth.

The consistence of the beak is variable. In birds of prey, it is remarkably hard, whilst in aquatic fowls it is very weak.

With regard to form, the beak presents yet more numerous varieties, and as it is in exact relation with the habits and species of food of birds, zoologists have studied these diverse modifications with particular attention. The beak of some birds of prey is compressed, curved into a hook with sharp cutting edges; some have them entirely straight, as the stork and heron; others are curved downwards, as in the *tantales*, or upwards, as in the *jabiri*. The beak of the penguin is compressed transversely; some are remarkable for their flatness, as the ducks are; and some are much elongated, as the *spatule* of the *vanneau*.

The horny covering of the two mandibles is sometimes covered with little elevations, or notches, which represent a species of teeth. A little within, at the point where the mucous membrane of the mouth is united to the substance of the beak, indentations are found, particularly in the duck, very regularly arranged, and formed by a horny membrane, continuous on one side with the substance of the beak, and on the other with the mucous membrane of the mouth. A number of filiments of the inferior maxillary nerve come from the lower jaw-bone, go towards the points which represent the alveoli, and are lost in the notches above described.

Carus compares the horny substance of the beak to the nails, and in the adult, at least, there is most analogy between these two parts. It would appear, however, from the researches of M. Geoffroy St. Hilaire, that in young birds there is to be found upon the two edges of the beak, elevations, which he considered as true rudimentary teeth, the number and form of which he carefully indicated.

M. Geoffroy found also in the *souchet*, horny laminæ coming from the external part of the palate, which he compared to the fanons of the whale. I have observed an arrangement similar to this in the ordinary duck.

ORDER III.

THE TEETH OF REPTILES.

Nature appears to have desired to mark clearly the position of reptiles in the zoological scale by the characters which she has given to the dental system of these animals. Occupying a place between birds and fishes, reptiles partake equally of the dental characteristics of both great classes. The tortoise has a beak like birds, and other reptiles closely resemble fishes in the form, number and principal characters of their teeth.

I have little to say of the beak of the tortoise, after the description I have given of that of the bird, as the parts are closely analogous to each other. As in birds the beak of the tortoise presents little elevations, which have been regarded by some as the rudiments of separate teeth. The only important distinctive character of the beak of the tortoise is the existence of an osseous plate attached to but not implanted upon the jaws under the horny lamina. In consequence of this formation, an analogy may be drawn between this beak and the human teeth ; the calcareous plate representing a range of teeth united together, of which the horny layer may be considered the enamel. According to M. Blainville, true teeth are found in the *trionyx*, a family very analogous to the crocodile, implanted in the jaws, which in these animals are pierced with regular holes. The last researches of M. Geoffroy St. Hilaire gives great weight to this view.

With the exception of the *chelonians* all reptiles have true teeth which are analogous to those of man, and the study of which may, in more than one point of view, throw light upon the natural history of the human teeth.

The teeth of reptiles are pointed and conical, answering very imperfectly, if at all, the purpose of grinding; they constitute, however, very effective weapons of attack and defence, and for the prehension of aliments may be classed with those of carnivorous animals.

From the preceding, the reason why the teeth of reptiles are

generally curved backward in the form of a hook, with the concavity posteriorly, will be at once apprehended. In consequence of this disposition, they are much better fitted to seize, draw in and retain their prey the resistance they offer to the escape of any body from their mouth is such that they will break sooner than relinquish their hold.

Reptiles have a greater number of teeth than man; it is considerable, but has not yet been exactly determined, however, it is but of little importance. Their teeth are generally like the human teeth implanted in the jaws, but sometimes as in most serpents they are attached to the palate.

The teeth of reptiles belongs to the class comprising those without roots, of some of the mammalia, and as those they are hollowed into a similar cavity for the lodgment of the pulp. The teeth are placed, at least those attached to the jaws, in alveoli, which are more narrow at their external opening than towards the bottom, and as their base is in exact proportion to the volume of the bottom of the alveoli, it will be readily conceived that their attachment must be very firm.

The teeth of the animals so nearly resemble each other that it is impossible to separate them into distinct classes, as we do the human teeth. They resemble the canine teeth more than either the incisors or molars, it may be said, indeed, that they belong to this class. There are sometimes indentations upon the free extremities; the maxillary teeth of *lizards* are three pointed.

The teeth of reptiles are generally developed at a very early age; this is particularly the case with the crocodile. These animals, says Cuvier, always have the same number of teeth; those which have just issued from the egg have as many as the animal twenty feet long. They grow like the human teeth by the addition of concustric lamellæ, and as their pulp is conical, they would increase indefinitely if they were not retained in the alveoli from its peculiar shape, being narrower at the opening than towards the base.

Reptiles appear to be endowed, in a greater degree than most other animals with regard to the facility and frequency with which their teeth are shed. At whatever age a tooth of the crocodile is extracted, another one will always be found under it,

either in the alveolus or in the cavity of the tooth itself; sometimes under the form of a little shell, very thin and short; some times more advanced and ready to take the place of the old tooth when it is shed. This succession takes place so frequently that young or old, these animals are always furnished with new, sharp and effective teeth.

With age the teeth of these animals become longer and larger. In this respect no comparison can be drawn between the young and old crocodile. Their dimensions are always proportioned to the size of the animal, and particularly to the dimensions of the maxillary bones. In proportion to the development of these bones, the openings of the alveoli are enlarged, and the tooth, the growth of which, in length, appeared to have been prevented by the narrowness of this opening, now receives new calcareous depositions internally, by which they are thrown outwards.

The manner in which the work of replacement is accomplished in reptiles, varies a little, which will be the only question in detail. We will only say, that the same regularity in the shedding of the teeth which is observable in the mammalia, and particularly in man, is not to be looked for here.

In the *samiens*, with the exception of the *iguana* and *lucurta* tribes, teeth are found only upon the maxillary or inter-maxillary bones; their number varies from seventy-eight to one hundred and forty. Tenon first described the mechanism of their fall and replacement. The question very naturally arises here, how these teeth, closely embraced as they are by the narrow opening of their alveoli, can be shed. This is effected by the following process: the tooth of replacement in developing itself in the cavity of the tooth about to be shed, presses it against the alveolus, in consequence of which the latter loses its consistence and is soon broken up. The fragments remain in the alveolus, whence they are afterwards expelled by the vital forces. In crocodiles, rings are often found formed in the alveoli by the remains of the old teeth, through which the new tooth first showed itself.

The lizard tribe, accordingly, present remarkable peculiarities with respect to the manner of shedding their teeth. "The new teeth," says he, "are not formed in the cavities of old, nor do they make their way through the bodies of the latter, as in

the crocodile; they are formed near the internal face of the base of the teeth, or in certain species in the thickness of the bone itself, either above or below, according to the jaw. In the latter case, examples of which are to be found in the *safe-guard* and *dragon*, a cavity is formed in which the development of the pulp and bony shell begins. This cavity gradually opens to the internal face of the maxillary bone. When the new tooth is formed near the base of the preceding tooth, the pulp is developed under the gum, simply; but in proportion to the development of the dental shell, a groove is formed in the nearest part of the old tooth, by which it is partially covered. Then it appears as if the new tooth is in the old one, but it is never entirely enveloped by it.

"In whatever manner the new tooth is formed, it comes at a moment when by its increase the old tooth is entirely supplanted, which falls in consequence of the necrosis of its ossified base, whereby its connection with the jaw is broken up. This is not a spontaneous rupture like that which takes place in the old horns of the stag, which fall before they are pressed upon by the new ones. It has always appeared to me, that the new tooth was of some importance in assisting the mechanism of dentition."

The *ophidia* have teeth both upon the jaws and palate. They all have, with the exception of the *amphibæna*, two parallel ranges of teeth on each side of the superior jaw.

In venomous serpents, the teeth particularly curved backwards in a semi-circular form, with the concavity posteriorly, and adherent to the superior maxillary bone, constitute the venomous fangs. The fangs generally occupy the anterior of the jaw; some serpents, however, make an exception to this rule, having them placed posteriorly. The fangs are not movable, as has been generally believed, but are fast soldered to the bone; the movement which they appear to make, is communicated to them by the jaw itself, which has a peculiar mobility. They are much longer than any of the other teeth. Their free extremity is blunted and pierced by a hole, which is the external termination of a canal that traverses the tooth in its whole length, and which receives the excretory duct of the

gland that secretes the venom. In the membranous sac which surrounds the base of the fang, a certain number of rudimentary fangs are placed; as many as eleven have been found disposed so as to take the place of the one in use, when it is shed. These rudimentary fangs are formed in membranous capsules, arranged parallel to each other, in the substance of the palatine membrane. Their order, with regard to dimension, depends upon their proximity to the tooth in service. When the latter has fallen, the adjoining fang takes its place, the base of which remaining membranous, is attached so accurately in the position of the one just shed, that the opening of the canal is exactly opposite to the duct of the venomous gland.

The teeth of the *batrachians* are much less important as regards their utility, than those of other reptiles, but in a zoological point of view, they furnish data, which should not be overlooked. All the *batrachia*, the toad, the *pipa*, and perhaps the *syren* excepted, have teeth in both jaws. All except the *pipa* have teeth in the roof of the palate. The pipa is entirely deprived of teeth; the toad, and perhaps the *syren*, has only palatine teeth, whilst all the other tribes belonging to this order have both maxillary and palatine teeth.

ORDER IV.

THE TEETH OF FISHES.

In the dental system of fishes a great variety is found, both in respect to the number and arrangement of the parts of which it it is composed. It is impossible, and fortunately, unnecessary, to determine the number of these parts. All that is of importance, at present, is to ascertain their position and form.

Fishes are furnished with teeth upon all parts of the internal face of the mouth proper, and of the pharynx, besides other productions of the skin of the vicinity which M. Blainville wished to consider as true teeth. The teeth of fishes have been distinguished into *inter-maxillary*, *mandibulary*, *palatine*, *vomerial*, *lingual*, *branchial*, and *phayngeal*.

But it is not sufficient merely to know, in a general manner, that the teeth of fishes occupy such and such portions of the entrance to the dental canal, it is necessary also to ascertain the special manner of their implantation. The teeth of the animals, now under consideration, may be in this relation divided into two species, those which are lodged in particular alveoli, (poissons osseux *gnatodontes* of M. Blainville,) and those which are placed at a distance from the maxillary bones which do not furnish cavities for them, as in all the truly cartilaginous fishes, with the exception of the saw-fish. The former are perfectly firm and immovable, whilst the latter are movable, and susceptible of erection and depression, as is evident in the shark.

The circumstance of the teeth being attached to the mucous membrane, without any connection with the bone, is a conclusive fact in favor of the theory which represents the teeth as simple productions of this membrane. In certain anomalous cases, as I have already mentioned, similar teeth have been produced in the human subject, marking the analogy existing between him and more inferior animals.

The teeth of fishes vary more, if possible, in form than in any other respect. Some are pointed and others have flattened surfaces, for which reason they are called *dents en pavé*. The pointed teeth, which are the most numerous, have sometimes but a single point, and sometimes two or three, as in the *squalus* and *roussette ;* these teeth are directed inwards and backwards, the better to enable them to retain their prey and to offer no obstacle to deglutition.

The *dents en pavé* of the ray are flattened or a little raised in the centre, in the form of transverse bands, whilst the sides are square; the greater number, however, have an even surface. They appear to be formed, according to Desmoulins, of a bundle of little tubes, united at the summit by a common layer of enamel. In a fish, classed with the *scarius*, by Cuvier, the teeth form five or six ranges, each composed of five or six teeth, which are all united by a kind of cement.

The teeth of the osseous fishes, which are implanted in alveoli, are, after their complete development, closely soldered to the circumference of the cavity in which they are placed.

According to *Desmoulins* the base of the pharyngeal teeth of the cyprenus, present, a foramen which performs a very important part in the work of replacement of the teeth. He says: "the pedicle of the tooth of replacement is carried towards this hole, and as it becomes more elastic as the formation of the tooth advances, the latter, I conceive, is drawn toward the place it is to occupy."

"All the alveolar teeth of fishes are fixed upon their alveolar border, at a certain stage of their development, and after the lapse of a time, which varies, they are replaced by new teeth, in a manner, not, however, perfectly understood. "Sometimes," says M. Blainville, "the teeth of replacement take the position of the teeth which they succeed, as in the mammalia; again they appear at the side of the other in a very irregular manner, as for instance in the pike. In the ray, the *squalus*, and fishes of which the teeth are compound, as the *diodins*, the *tetraodons*, the *scaræ*, new ranges of teeth appear on the posterior or interior border of the old."

From such facts the habits and species of food of the fish may be easily ascertained. The fishes armed with numerous sharp teeth inclined strongly backward, as in the *pike*, or denticulated and cutting, as in the shark and *squalæ*, should be classed among the most voracious, the most carnivorous of the inhabitants of the waters. Those on the contrary which are furnished with simple or flattened teeth, as the *dorado*, and many other *sparoids*, and those which have only pharyngeal teeth, should be considered as the least carnivorous of all. Finally, the fishes I have described as having complicated teeth, formed like grinders or *pavés*, so well formed for grinding or crushing hard substances, feed upon shell-fish, and frequent those waters where they abound.

APPENDIX.

OF THE PARTS WHICH REPRESENT THE TEETH IN INVERTEBRATED ANIMALS.

The parts we are about to describe in a very general manner, as the teeth of the invertebrata, have certainly this analogy with the teeth of vertebrated animals; they are placed at or near the entrance of the alimentary canal; they serve to seize, retain and comminute the alimentary substances. But this analogy, in a functional point of view, does not, necessarily, imply a corresponding analogy of organization. Nature is able, doubtless, to attain to the same end by the employment of different means, and it appears to me that she has done so in this case.

The dental organs of these animals are dependencies of the tegumentary membrane, and are productions of a calcareous or horny nature. But between these and the teeth, that is, those organs furnished with a special follicle, in which is secreted the bony substance of the tooth, which, after a certain time, makes its appearance through the gum, there are very great differences, differences which have, with reason in my opinion, prevented Cuvier from classing them together.

Taking all the facts into consideration, I think a much greater analogy exists between the teeth and the hair, than between them and the so-called teeth of invertebrated animals. Doubtless, in the classification of the masticatory organs, we should necessarily take in both, but it would be always necessary to divide them into two distinct classes, one of which should comprehend the teeth, the other the odontoid organs of the invertebrata.

There is a fact which deserves particular attention in this inventory of the dental organs of invertebrated animals; it is this: these animals have those parts representing the teeth placed in the stomach. It will be observed that the masticatory organs of the invertebrata are submitted to a rule to which nature appears to have confined herself in the constitution of the masticatory organs. The higher the animal is elevated in the scale, the higher are the dental organs elevated in the alimentary canal. In the crustaceæ and mollusca, they are placed principally in the stomach; in fishes, they reach the pharynx; in reptiles, the posterior part of the mouth, whilst in the mammalia they are confined to the anterior and lateral parts of the mouth.

In the mollusca the true masticatory organs are situated, without exception, in the stomach; the detached stony shells of the *tarets* and the *unios;* the tenaculæ which surrounds the mouth in the *balaines* and *huitres*, are undoubted organs intended for the prehension of aliments, but do not appear to be in any other manner assimilated to the teeth.

The aplysia of all the mollusca has the most complete masticatory apparatus. According to Cuvier's description, the crop is furnished with a gizzard of a short cylindrical form; the walls of which are muscular and very strong. "They are furnished, interiorly, with a kind of armor, which is very extraordinary, and to which I can find nothing exactly analogous, although the osseous pieces of the stomach of the bullies may have some relation to them. They represent pyramids, with rhomboidal bases, the irregular faces of which are joined together at the summit by two or three blunt points. Their substance is semi-cartilaginous, composed of laminæ parallel to the base. Their number in individuals, from which I have carefully collected them, is about twelve large ones, placed in three ranges in a quincunx order, and some small ones arranged in the superior border of the gizzard. The attachment of these pyramids to the villons coat of the organ, is so slight that they are broken away by the slightest effort, without leaving any trace of their membranous or other means of union. Their places of adherence are well marked, however, by smooth and elevated surfaces, whilst the intervals between them are a little depressed and slightly wrinkled. The

free extremities of these pyramids are so arranged that their points touch in the middle of the cavity of the gizzard, and as there remains but little space for the passage of aliments, they are, consequently, broken up with much force.

The third stomach, as large as the first, though not so long, is furnished with an apparatus as singular as the second. A number of little pointed hooks attached to the internal surface of the stomach, but almost as slightly as the pyramids of the gizzard; their points are directed towards the gizzard, and I cannot conceive of any other use they perform than to arrest the passage of the food which has not been sufficiently triturated in that organ. The form of the alimentary substance is entirely lost in the third stomach.

The crustaceæ of all the invertebrated animals have the most remarkable gastrico-dental organs; they are calcareous productions, carried upon a kind of skeleton with which the stomach of the animal is armed. According to Cuvier, we find first a transverse ridge which occupies the middle of the stomach. This ridge is furnished with a tooth or oblong osseous plate, which is attached to the superior wall of the stomach, and is directed backward towards the pylorus terminating in a tubercle. Upon this posterior extremity is articulated a second ridge directed backwards, and bifurcated in the form of the letter Y upon each of the lateral processes, of which is articulated another which goes forwards and outwards to be united to the lateral extremity of the first transverse ridge.

Upon these two lateral ridges are placed the two larger teeth. They are oblong; have a flat crown, which is furrowed across the elevations, and furrows differing according to the species. In the crab *poupart* the crown is striated, and has upon its inferior border large denticulations, and forwards, a projecting part which is not striated. In the great lobster, there are nine transverse rib-like elevations, of which the three anterior are much the largest.

From the point of union of the transverse and lateral ridges comes off another lateral one which extends lower than the first, and has upon its extremity a lateral tooth, placed a little before

and under its anterior extremity, and furnished with three and sometimes five small sharp curved and pointed elevations.

The two teeth furnished with hooked points, seize the food taken into the mouth, and carry it between the two teeth with flattened crowns, and the first plate I described.

After having undergone this process, the food passes by the straight part of the stomach where its progress is again impeded, first by an oval fleshy projection, which corresponds to the interval of the two great lateral teeth, and then by a sharp crest, which divides the pyloras into two semi-canals.

Insects and worms have no organs which can be, with any appearance of reason, compared to the teeth of the superior animals. Some of the *orthopteræ*, the *acheta*, the *locusta*, and the *blattes* only have their stomachs furnished with scales or horny hooks, which have been supposed to be destined to perform a kind of mastication. At the entrance of the mouth of all insects the skin is harder than in any other part of the body, the epidermis appearing to have undergone a horny modification; but, as has been seen, this arrangement does not enable us to class it as a special dental apparatus. In the *radiata*, finally, without speaking of the tenaculæ which surround the mouths of these animals, and which have been compared, without much appearance of reason, to the teeth; some of them *echinis*, which are admitted to have special dental organs. In this class, in the oral opening of the shell, which looks downwards, there is, according to Carus, an apparatus of five branches, *lantern of Aristotle*, in each of which a long tooth is situated, and moved by many muscles.

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